

# New Scientist

WEEKLY November 12-18, 2016

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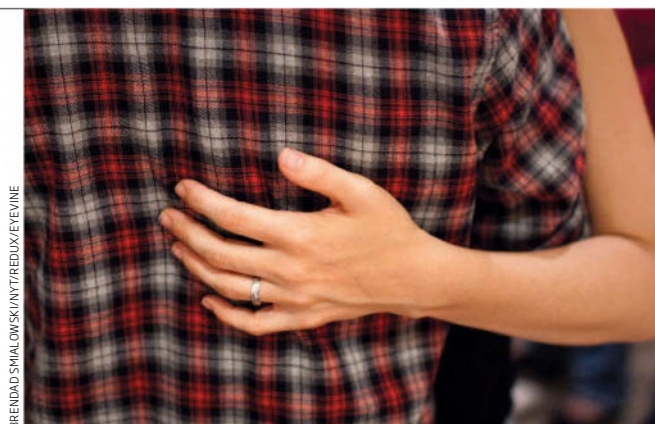
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BRENDA SHALOWSKI/ANT/REDUX/EVERETT

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### 60th anniversary special: The future

Intelligent machines, engineered climate, colonies on Mars: where we will be in another 60 years

**Plus** 1956 revisited and how our world's changed

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## Culture clash

An overdose of honour could be behind aggressive behaviour

DIGNITY or honour? Those two words seem to describe a binary divide in the sorts of human cultures that exist in our world. To a rough first approximation, dignity cultures value people for themselves while honour cultures do not. They are instead driven by an overriding concern for reputation and a sense of duty to retaliate when it is damaged, sometimes even to the point of killing a daughter or sister who is seen to have brought the family into disrepute.

When honour killings happen in the West, people tend to rationalise them as the product of an alien culture. And, indeed, such killings are most frequently seen in communities that have

close family ties to places like Pakistan, where a strict honour culture still holds sway.

But social psychologists have now shown that honour culture is also strong among white people in southern US states, where it is linked to social problems including high rates of murder and domestic and sexual violence (see page 32).

There are many reasons to question this simplistic and overarching analysis of complex social phenomena. Even so, the research suggests that honour culture exerts an influence on behaviour in more places than you might expect.

With that in mind, perhaps we should be looking for it in other

Western societies. It exists in gang culture, which suggests it is readily triggered under certain social circumstances. What about elsewhere? Honour cultures are characterised by economic insecurity, a sense that outsiders are taking advantage, and a rejection of universal rights. Sound familiar? It could be a portrait of parts of Brexit Britain, Marine Le Pen's France or other Western societies where the social contract appears to be fraying.

Honour culture may not be the underlying problem at all, but it is worth putting assumptions to one side and finding out whether it is – and what, if anything, could be done to bring a little more dignity to proceedings. ■

## Shaky foundations

WHAT'S worse: letting a baby-killer go free, or wrongly convicting a parent or carer of shaking a baby to death?

That agonising question was first brought to our attention in 1997 when British au pair Louise Woodward was convicted of murder – later downgraded to involuntary manslaughter – in the US. The controversy over “shaken baby syndrome” has

only intensified since then.

The latest twist is a report casting serious doubt on the symptoms of brain injury considered to be clear evidence of violent shaking (see page 8). It may throw a lifeline to people convicted of shaking a baby to death. But it is unlikely to be the last word. Several scientific societies have already expressed concerns about the study.

It goes without saying that the best scientific evidence ought to be available to both sides in a murder trial. For that reason it is vital that this report acts as a catalyst for further careful and dispassionate scrutiny.

However, the debate has become so toxic and polarised that it is hard to see it happening. In the UK, for example, nobody seems prepared to act as an expert witness for the defence. That must change, or else miscarriages of justice are sure to follow. ■

## Choking cloud hits Iraq

AT LEAST two people have been killed and hundreds more exposed to choking fumes after Islamic State torched up to 19 oil wells and a sulphur plant near Mosul in Iraq.

The militants began lighting the fires in August, possibly to mask their movements as US-backed Iraqi forces launched an offensive to retake the city. NASA images from 22 October show two huge plumes rising from the area, with dark brown smoke coming from the Qayyarah oil field and clouds of white sulphur dioxide from the Al-Mishraq sulphur plant.

The sulphur blaze was put out on 23 October, but the toxic fumes killed two and forced 1000 others to seek treatment for breathing problems.

Meanwhile, the ferocity of the oil fires has hampered the efforts of

local fire crews to extinguish them amid fears that explosive devices may have been planted around the wells.

Local people say the smoke burns their throats and lungs, blocks out the sun and coats their skin in black, oily soot. They are also experiencing headaches, skin rashes and chest pains, says Oxfam.

As crude oil burns it releases many toxic chemicals, including lead, carbon monoxide, polycyclic aromatic hydrocarbons and volatile organic compounds, says Bin Jalaludin at the University of New South Wales in Australia. These can harm the lining of the airways and lungs, making it difficult to breathe.

There is a risk that Islamic State will now set fire to the other six oil fields it controls near Mosul, says Oxfam.



Shrouded in toxic smoke

## GM superwheat

IT IS a whizz at photosynthesis, thanks to genetic modification. When a new strain of wheat is grown in greenhouses, yields rise by 15 to 20 per cent, a team at Rothamsted Research, Harpenden, UK, said last week.

The researchers will ask the government for permission to carry out field trials in spring 2017. The tests are essential to confirm that the alteration works, says team member Malcolm Hawkesford. "It works when you grow it in a pot in a

plateaued at around 8 tonnes per hectare. Getting more wheat from the same area of land would have massive environmental benefits – freeing up land to set aside for wildlife or to capture carbon, for example.

Hawkesford and his colleagues have added extra copies of an enzyme called SBPase, to increase the supply of a five-carbon molecule that often runs short in plants such as wheat. Plants make food by adding carbon dioxide from the atmosphere to this molecule. This modification will also help plants take advantage of rising carbon dioxide levels in the atmosphere. "In higher levels of CO<sub>2</sub>, this works even better," Hawkesford says.

The team say they have made other genetic alterations that also boost yields in greenhouse tests, although they are keeping the details to themselves for the moment. Several of these yield-boosting modifications could be "stacked" together in a single strain to create superplants. In a world of rising CO<sub>2</sub> and with ever more demand for food, they could make a big difference.

**"Getting more wheat from the same area of land would have massive environmental benefits"**

greenhouse," he says. "But in the real environment, you often don't see the same response."

If the plants produce anything like a 15 per cent increase in yield in real fields, it will be a spectacular result. "It's an extremely beneficial trait," says Hawkesford.

In the UK, wheat yields have

## Long March launch

CHINA just debuted its biggest rocket yet. The Long March 5 rocket blasted off from the Wenchang Satellite Launch Center off China's southern coast at 8.43 pm Beijing time on 3 November.

The heavy-lift rocket is a crucial part of China's plans to launch a permanent space station, robotic sample-return missions to the moon, and a future Mars rover. It is designed to be three times as powerful as the Long March 2F rocket, which brought China's

second space station, Tiangong-2, into orbit in September. Two astronauts are just over halfway through a month-long stay on Tiangong-2.

The main goal of the launch was to show that the rocket works. The successful flight clears the way for another Long March 5 mission as soon as 2018, to launch part of China's planned space station into low Earth orbit. It could also launch the Chang'e 5 robotic moon mission next year, and may launch a Mars orbiter and rover in 2020.

## India and Japan in nuclear deal

THE prime ministers of India and Japan were due to meet on Friday to sign a deal under which Japan can supply nuclear technology to India. This will allow India to add to its 21 existing nuclear plants.

The reactors will generate electricity from radioactive uranium. However, they will also create plutonium as a byproduct, which can be used in nuclear weapons, and India isn't bound by the nuclear non-proliferation treaty. This means

there are no international safeguards to prevent military repurposing of plutonium, say anti-nuclear groups.

India's relations with neighbours Pakistan and China have not been the best. Japan says it will end the deal if India carries out any nuclear tests.

"India has an impeccable record of nuclear non-proliferation," says Ashok Sharma at the University of Melbourne, Australia. "So, I don't think India will use the nuclear deal with Japan for making bombs."



## Ebola evolves

IT WAS already bad enough. Now virologists have found that Ebola quickly learns to spread more readily among humans – and becomes a deadlier disease.

The recent epidemic in West

GRAHAM MONRO/GETTY



Thirsty for milk, not debate

**"The mutation may have made the virus nastier; people with it were more likely to die"**

Africa was by far the biggest ever, striking at least 28,600 people and killing 11,310. This seems to have given it the opportunity to adapt. Very early in the epidemic, when the virus invaded Sierra Leone, it acquired a mutation in the part of its main surface protein that binds to the cells it invades. The appearance of the mutation, called A82V, coincided with acceleration of the epidemic.

Now two separate research teams have found that A82V allows the Ebola virus to infect human and other primate cells up to four times more efficiently than the unchanged virus (*Cell*, [doi.org/bssd](http://doi.org/bssd), [doi.org/bssf](http://doi.org/bssf).)

The mutation may have made the virus nastier. People with A82V had more of the virus in their blood, and were significantly more likely to die.

West African Ebola also mutated in ways that might blunt the effectiveness of vaccines, or our own immune responses.

## Breast milk rules

HOSPITAL guidelines aimed at getting more women to breastfeed don't work – and are making some newborns ill.

The standard advice worldwide is that mothers who can should try to exclusively breastfeed their babies for at least the first six months. Global guidelines from UNICEF state that women trying to breastfeed should avoid using occasional bottles of formula milk, even in the first few days

**"Hospitals should reconsider bans on formula as they risk causing unnecessary harm"**

after birth when they might not be making much milk. Parents can also be told not to give their baby a dummy in case they suck this in place of the breast.

Now, medical body the US Preventive Services Task Force says there is no evidence that either strategy raises the amount of breastfeeding. Its updated review of such strategies warns that while giving one-to-one support to women struggling with breastfeeding is helpful, there is no evidence for blanket bans on formula and dummies (*JAMA*, [doi.org/bssm](http://doi.org/bssm)).

Valerie Flaherman at the University of California, San

Francisco, warns in the same journal that denying access to formula to babies who might need it is leading some to become dehydrated and jaundiced, while dummies seem to reduce the risk of cot death, also known as sudden infant death syndrome. She says hospitals should reconsider bans on formula as they "risk causing unnecessary harm".

## Air pollution win

THE UK government has been ordered to tackle air pollution as soon as possible. The High Court in London ruled last week that its current plan is illegal.

This is the second legal defeat for the government on this issue: its clean air plan was drawn up after it lost a long-running case in 2015. Both cases concern levels of nitrogen dioxide, an invisible gas produced mainly by road traffic. High levels of nitrogen dioxide shorten lives by increasing the risk of heart attacks, strokes and respiratory disorders.

But the government's plan consisted of introducing clean air zones in just five cities, which wouldn't get pollution below legal limits before 2020 in most areas.

"We hope the new government will finally get on with preparing a credible plan," says Alan Andrews of campaign group ClientEarth, which brought both cases.

## 60 SECONDS

### Listen up

The Parkes radio telescope in Australia has started listening to nearby star Proxima Centauri to see if alien signals are coming from its planet. The search is part of a \$100 million, 10-year project set up by Yuri Milner and Stephen Hawking. The telescope will devote 25 per cent of its time to the project for five years.

### It's rude to share

Facebook has been forced to halt controversial plans to use data from UK WhatsApp users – for now. WhatsApp planned to share information such as phone numbers with its parent company to help with ad targeting. But the UK's information commissioner, Elizabeth Denham, said the company had not adequately informed users.

### Apes need specs

Middle-aged bonobos could do with glasses. Like people who must hold a book at arm's length when they get older, bonobos groom friends further away as they age and their eyes lose focus. The 10-centimetre grooming distance for 30-year-olds doubles to 20 cm for 40-year-olds (*Current Biology*, [doi.org/bssj](http://doi.org/bssj)).

### Meteorite on Mars

The Curiosity Mars rover has zapped a golf-ball-sized rock with a laser and found it to be an iron-nickel meteorite that fell onto the Red Planet. Previous examples of meteorites have been spotted on Mars, but this one, called Egg Rock, is the first to have its chemistry analysed with a spectrometer.

### Sweet dreams

People who sleep for 5 hours or less a night drink significantly more sugary, caffeinated drinks, according to a study of more than 18,000 adults (*Sleep Health*, 10.1016/j.sleh.2016.09.007). The team didn't determine if one factor causes the other, but they think sleep loss and these drinks may reinforce each other in a positive feedback loop.



Brothers in nuclear arms

ANAN ABIDI/REUTERS

# Shaken baby science questioned

Crucial set of symptoms isn't a sure sign of child abuse, finds **Andy Coghlan**

PEOPLE who have been convicted of shaking infants to death may have new support for appealing their convictions. An extensive review has concluded that there is no solid scientific evidence that a specific pattern of head injuries is incontrovertible evidence on its own of child abuse.

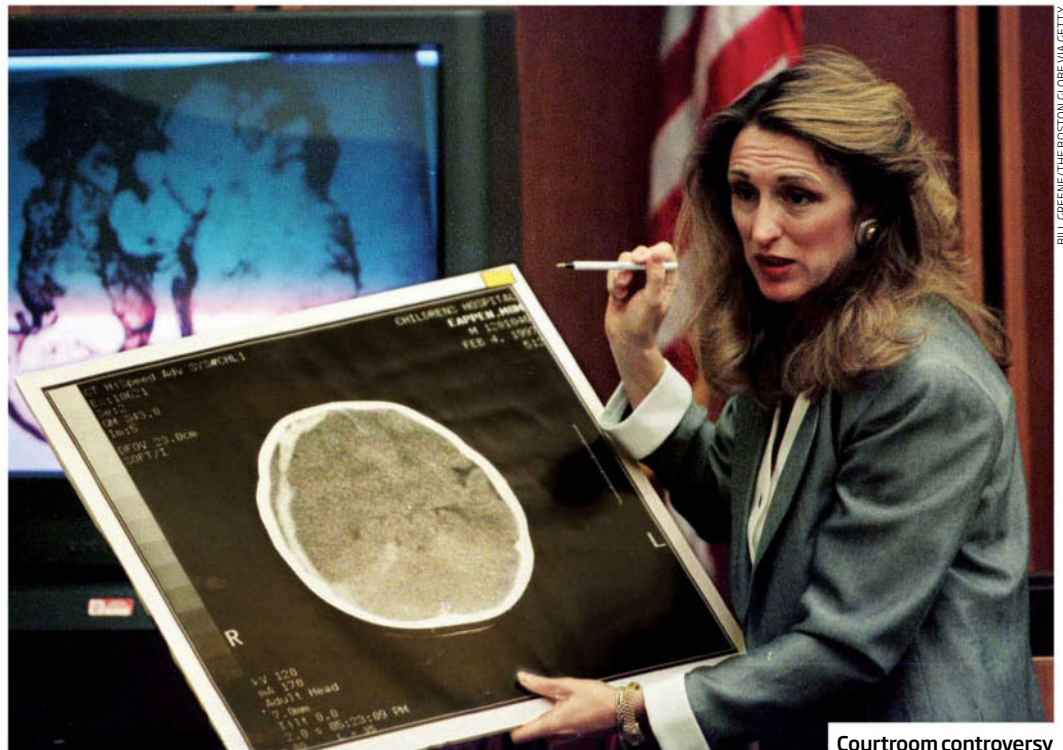
Formerly known as shaken baby syndrome, abusive head trauma is a combination of symptoms believed to result from violently shaking an infant – an action that usually has long-term health consequences and can be

**"Critics are afraid people who've abused infants might go free, or parents will cover up abuse"**

fatal. Three symptoms in particular – swelling of the brain, bleeding on the brain's surface and bleeding behind the retinas – have together been used as crucial evidence in court. In many countries, including the UK and US, this triad of symptoms, sometimes in the absence of other physical signs of harm, has played a key role in convictions for abuse.

But there is growing debate over whether these symptoms can have other causes, and the latest study could throw some existing convictions into doubt. The study's findings imply that "we've been breaking up families and imprisoning caretakers – with at least three in the US still on death row – based on flawed forensic science", says Heather Kirkwood, a lawyer in Seattle.

To examine the quality of evidence supporting the triad alone as a hallmark of child abuse, a team in Sweden narrowed 3700 abusive head trauma studies down to 1000 that were relevant to the triad of symptoms. Of



Courtroom controversy

these, 30 met their strict criteria, such as having a large enough sample size, and not including cases that involved extra injuries in addition to the triad. Of these, they deemed only two studies, both conducted in France and

published in 2010, to contain plausible evidence that the triad of symptoms, in the absence of other injuries, point to child abuse. However, the team decided that these didn't show sufficient support for the triad alone as

definitive evidence of abuse, in part due to a lack of detail about the adults' confessions of shaking.

"Our main finding is that there's very low-quality scientific evidence for the claim," says Niels Lynøe, a specialist in general medicine at the Karolinska Institute in Stockholm, and leader of the team, whose report was published last month. "You can't use these studies to say that whenever you see these changes in the infant brain, the infant has been shaken – it's not possible according to current knowledge."

## Alarmed response

While the team didn't seek to determine alternative causes of the triad, some studies suggested small falls or bleeding in the head during vaginal births may also be

## CAN'T GET A WITNESS

Despite questions over evidence for "shaken baby syndrome", there is a lack of expert witnesses willing to speak on behalf of UK defendants.

Pathologist Waney Squier, at John Radcliffe Hospital in Oxford, has previously argued that, on their own, the triad of symptoms taken as a sign of child abuse may have other causes. But her court appearances led to her being struck off the medical register in March. A High Court judge ordered her reinstatement last week, but she

is banned from giving court evidence for three years.

Her experience could deter others. "I still feel that it's not safe to give an opinion, so I can't risk my job by giving evidence in court," says Irene Scheimberg at the London Hospital, one of the few other experts in the UK who could speak on behalf of the defence.

"Expect to see a lot more false convictions in the UK," says Heather Kirkwood, a lawyer in Seattle.



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associated with these symptoms.

The conclusions have prompted alarm among some doctors. *New Scientist* has seen letters sent prior to publication expressing concern over the report's content.

The American Academy of Pediatrics (AAP), the Society for Pediatric Radiology in the US, and the European Society of Paediatric Radiology (ESPR) all urged the SBU – the Swedish agency that commissioned the report – to let them see a draft and have a say on the contents of the report before publication.

"Quite a few courts have recognised there's a legitimate controversy," says Kirkwood. "If the courts take the next step and recognise that there is no reliable evidence base for abusive head trauma, the next logical step would be to eliminate prosecution testimony on this. For obvious reasons, opponents of the report don't want this to happen – hence the last minute effort to stop the Swedes from publishing."

"What we wanted was a chance to review it before it was published," says Robert Block, chairman of the US charity National Center on Shaken Baby Syndrome, and a former president of the AAP. The SBU declined to let the societies comment on the report before publication, with director general Susanna Axelsson telling them it had already been extensively reviewed by external experts, as well as carefully looked over by the SBU board of directors and scientific advisory board.

But this hasn't stopped criticism of the report. Three of the six-member study team has no knowledge of abusive head trauma, says Block, who also criticises recent court cases. "There has been a groundswell of biased, incorrect and sometimes outright lying in courts, and gullible media that misrepresent the facts about the diagnosis of abusive head trauma," says Block.

The report is currently being translated into English. "We are

reserving our opinion until we have seen an official transcript, but fear their conclusions will cause diagnostic difficulties," says Amaka Offiah, chair of the ESPR's child abuse task force.

## Legal impact

Lynöe says opposition to the report is understandable. "They're afraid people who have abused infants might go free, or that parents will use the report as a cover-up for abuse," he says.

But the report has been backed by Iain Chalmers at the Cochrane Collaboration, which conducts evaluations of scientific evidence in health that are often considered the gold-standard in systematic reviews. The team seems to have done a thorough job, he says.

Critics argue that the so-called triad isn't solely relied upon for diagnosing abusive head trauma. "The diagnosis is made when thorough physical, radiological, laboratory and other examinations point towards trauma, and confessions by adults who have injured children help our understanding," says Block. Courts seldom look at the triad on its own, says Offiah.

However, confessions are problematic, and Lynöe says that a reliance on these is at the heart of why scientific support for the triad is so weak. Studies involving confessions often fail to explore whether other events, such as breathlessness, unconsciousness or choking, may have occurred before the confessed shaking.

The study's conclusion may affect several ongoing legal cases in the UK. "We have both appeals and new cases at various stages of development," says Bill Bache, a lawyer in the UK. The Swedish report is welcome, he says, but arguing its findings in court is likely to be difficult due to a lack of expert witnesses to call upon (see "Can't get a witness", left). "There are not many people who can speak authoritatively about this issue," he says. ■

# We're missing 75% of worlds with two stars

**BINARIES** are twice the trouble.

The shifty geometry of planets that orbit two stars means we've missed about 75 per cent of these worlds – but we are playing catch-up.

Planets that orbit two stars are truly alien – and they are also trickier to discover and study. Unlike planets around single stars, they shift their orbital paths over just a few years.

The Kepler space telescope has spotted 10 of those worlds by watching them transit – cross in front of their stars from our point of view. Transits around just one star run like clockwork: once you know how long the planet's year is, you can predict exactly when it should next pass in front of the star.

But binaries have more moving parts. The planet could orbit its stars in the same plane, or adopt its own separate plane. The angle of its orbit with respect to the stars' plane shifts with each trip around the binary. Sometimes the planet will transit as it goes around. Sometimes it won't.

Since the easiest way to find the planet is when it transits, we really need to know when to look – a tricky problem only solved by number crunching on high-powered computers.

In 2015, David Martin at the Geneva

Observatory in Switzerland started looking for an easier way. First, he and his colleagues devised equations to calculate whether a circumbinary planet would transit at all – an easier technique than running simulations.

"It showed you'd get loads of transits, but it didn't really let you know when," Martin says.

Now, he's calculated when a planet's orbit crosses in front of the orbital path of its stars. That gives astronomers specific windows in which they have a good chance of spotting a transit.

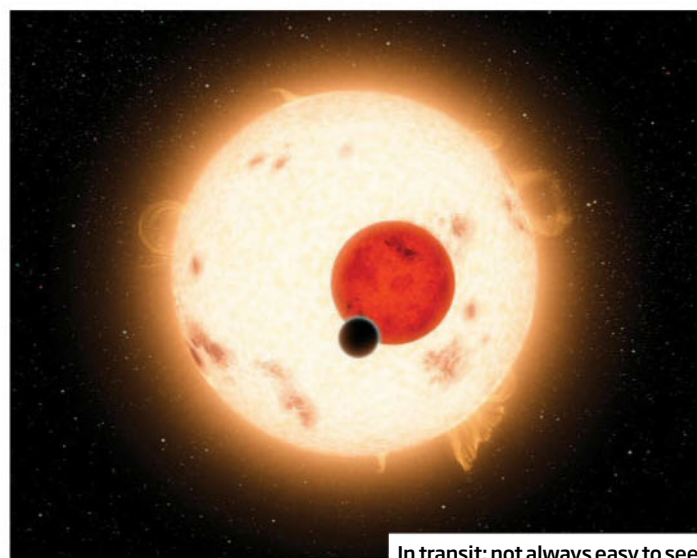
Martin also quantified how lucky Kepler was to see those 10 planets transit during its four-year mission. Extrapolating that chance suggests that 30 more planets may lurk unseen in the same systems, ([arxiv.org/abs/1611.00526](https://arxiv.org/abs/1611.00526)).

"Using the results here we can estimate how many we miss, making it much easier to understand the whole population," says David Armstrong at the University of Warwick, UK.

Next, Martin hopes to pinpoint future transits precisely.

"Calculating that probability is bloody hard," he says. "I'm trying to do it but I haven't figured it out yet."

Joshua Sokol ■



In transit: not always easy to see

# Huge lake 15 km under volcano

Andy Coghlan

OUR planet is blue inside and out. A massive reservoir of water has been discovered deep beneath a volcano in the Andes, and similar wet pockets may be lurking below other major volcanoes.

The unexpected water, which is mixed with partially melted rock, could help to explain why and how eruptions happen, and may be playing a role in the formation of the continental crust we live on.

Jon Blundy of the University of Bristol, UK, and his team made the discovery while studying a huge anomaly 15 kilometres beneath the dormant Uturuncu volcano in the Bolivian Andes. The anomaly slows down seismic waves and conducts electricity, unlike surrounding magma.

Blundy's team mixed rocks spat out by an eruption of Uturuncu 500,000 years ago and mixed them with various amounts of water before exposing them to conditions mimicking those in the anomaly. This included pressures 30,000 times as high

as atmospheric pressure, and temperatures up to 1500 °C. "We reproduced conditions deep in the Earth in the lab," says Blundy.

They found that at a particular water content, the mixture's conductivity matched the value measured in the anomaly. "By weight, we calculated it contains 8 to 10 per cent water," says Blundy.

This means that the anomaly

contains as much water as some of the world's largest freshwater lakes (*Earth and Planetary Science Letters*, doi.org/bsrf). "It's probably somewhere between Lake Superior and Lake Huron," says Blundy. "It's a staggeringly large amount."

Similar anomalies have been found beneath other volcanoes, such as those in the Taupo Volcanic Zone in New Zealand, and Mount St Helens in Washington state. It's likely these are also signs of secret reservoirs.

"This study illuminates a new feature of Earth's deep-water cycle, and reminds us how little we know about the pathway of

water through Earth's crust and mantle systems on geologic timescales," says Steve Jacobsen of Northwestern University in Evanston, Illinois.

We can forget about extracting the newly found water. "It's dissolved in partially melted rock at 950 to 1000 °C, so it's not accessible," says Blundy.

But higher water content in magma may help to explain the composition of continental crust. When magma in the mantle – mainly made of basalt – rises into the crust, the water helps enrich it with silica and deplete it of magnesium, forming rocks like the andesite found beneath the Andes. "The process in Uturuncu is a microcosm of continental crust formation, and involves much more water than we thought, probably twice as much," says Blundy.

Water is also one of the volatile components dissolved in magma that drives volcanic eruptions, he says. "Dissolved at shallower depths where the pressure is lower, it comes out as bubbles, which end up as an explosive eruption."

Understanding more about how water can trigger eruptions could help geologists better interpret seismic activity, perhaps improving predictions. ■



MICHAEL SAWLES / ALAMY STOCK PHOTO

Not as dry as it looks

## Implants let paralysed monkeys move

COULD hacking our reflexes allow paralysed people to walk again?

Some animals have walking reflexes governed by nerves in their spine – it's why a chicken continues to run after its head has been cut off. Now these reflexes have let paralysed monkeys regain use of their legs after a week or two of practice. Previous methods have taken months.

We have no reliable means to reconnect severed nerves in people with injured spinal cords. One way to

overcome paralysis might be to detect a person's desire to move and use this to stimulate nerves or muscles.

Last year, a paralysed man walked thanks to a cap of electrodes that read his brainwaves, and implants that stimulated his leg muscles. But directly stimulating muscles in this way can make movements jerky and uncoordinated. "Walking is a very complex behaviour: you need to coordinate the activity of hundreds of muscles and maintain balance," says Grégoire Courtine at the Swiss Federal Institute of Technology in Lausanne.

This coordination is usually carried out by circuits in the spine, which control walking once it has been initiated by the brain – as happens in

headless chickens. Courtine's team has found a way to exploit this using spine implants in monkeys.

The spinal cord was severed on one side above the implant, and a second implant put into the part of the brain that controls the affected leg. This implant detected when the monkey wanted to move and sent signals to the device in the spine. Within six days, the first monkey was crawling using both legs. A second animal did so in two weeks (*Nature*, DOI: 10.1038/nature20118).

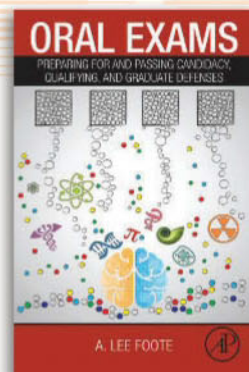
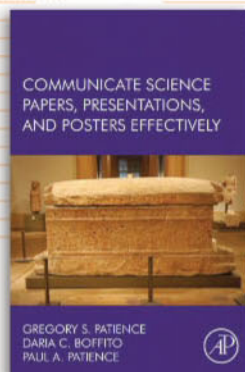
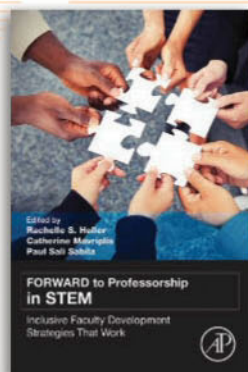
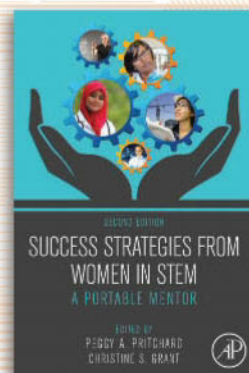
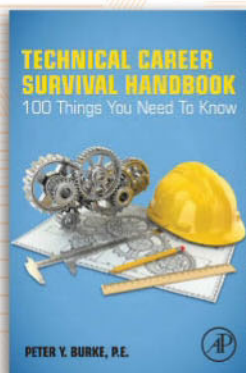
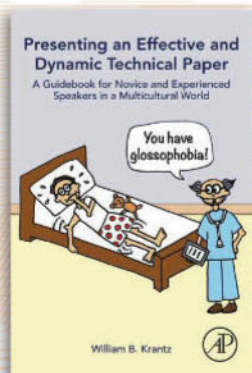
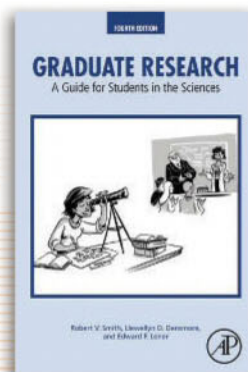
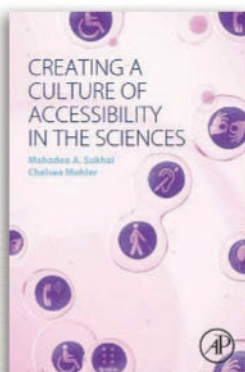
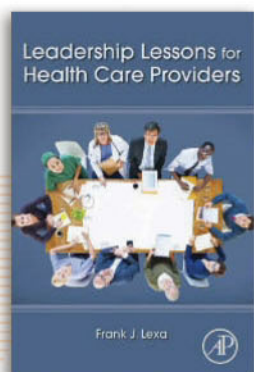
**"Walking is very complex: you need to coordinate hundreds of muscles and maintain balance"**

This is the first time implants have reversed paralysis in monkeys. "We are turning a corner," says Chad Bouton at the Feinstein Institute for Medical Research in New York, who was not involved with the study.

But Courtine says it is unclear if reflexes could let paralysed people walk upright as easily. And the method might not work for long. Bouton's team has used this kind of implant to return arm movements to a paralysed man, while another team used implants to give a person control of a robotic arm. But such implants tend to stop reading the signals so well after a few years. Both groups are now working on making them last longer. Clare Wilson ■



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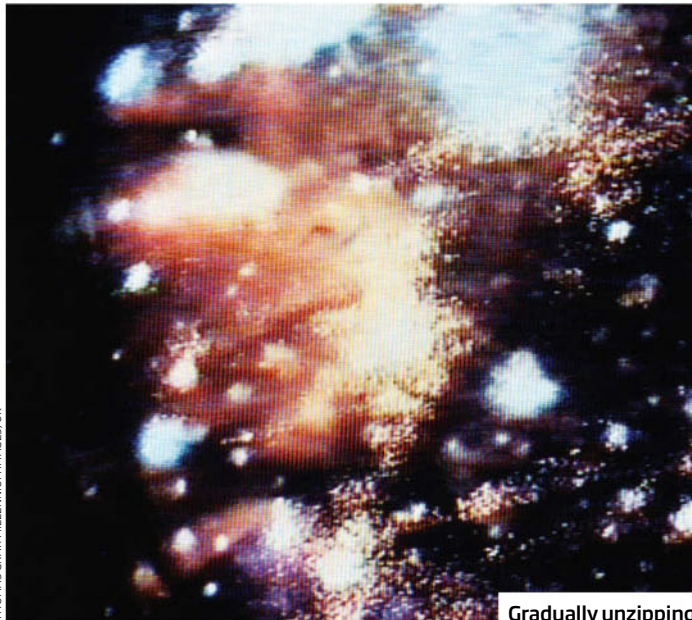


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Gradually unzipping

# Universe headed for 'Little Rip'

Rebecca Boyle

THE end of the universe is about to get interesting. Most data favours a slow fade into a silent, frozen oblivion. But a new analysis suggests the cosmos could gradually tear itself apart, galaxy from galaxy and atom from atom. Or at least, we can't rule it out.

We know that the universe mostly consists of dark matter, which only interacts with regular matter via gravity, and dark energy, a mysterious, unseen force thought to be accelerating the expansion of the universe.

Now, it seems the distribution of dark energy favours a gradual rip as the eventual fate of our universe, says Mariam Bouhmadi-López at the Technical University of Lisbon in Portugal.

Depending on how dark energy behaves, there are a number of possible end-time scenarios. In the most popular, it causes expansion to accelerate steadily over time, until galaxies, stars

and atoms grow too distant and cold to interact – a Big Freeze.

But if dark energy behaves differently so that the acceleration rate is not constant and increases with time, it will eventually tear everything to bits in a kind of rip.

For that to happen, dark energy would have to take a mysterious "phantom" form, which gets denser as the universe grows. That flies in the face of everything else we observe – density normally decreases as volume expands.

"We don't know of anything that behaves this way," says David Spergel at Princeton University in New Jersey. "But that doesn't mean it can't happen."

Bouhmadi-López and graduate students Imanol Albarran and João Morais studied three versions of this tear: the Big Rip, the Little Sibling of the Big Rip and the Little Rip. The main difference is the way in which things come undone: in a Big Rip, the universe abruptly rips itself to shreds at a fixed point in the future, but in

the littler versions, it happens more gradually. "What they have in common is that our galaxy, and all galaxies, would be ripped apart," Bouhmadi-López says. "Everything goes wrong."

The way matter clumps can tell us which rip the universe might head for. Dark matter and regular matter are more concentrated in some areas of the universe. Those clusters lead to variations in gravity, which can make time run differently in those areas. That could mean that in some regions of the cosmos, dark energy acts at a faster or slower rate.

Bouhmadi-López and colleagues studied these differences using observations from the Wilkinson Microwave Anisotropy Probe and the higher-resolution Planck satellite, which released its latest map of the cosmos in 2015.

They concluded that the most likely scenario is the Little Rip, in which the universe's expansion slows down just enough that we experience a gradual unzipping, rather than a cataclysmic tear (arxiv.org/abs/1611.00392).

"They've been able to come up with some observational signatures that are different in these models, and in the future we will be able to use that," says Robert Scherrer at Vanderbilt

**"Our galaxy, and all galaxies, would be ripped apart. Everything goes wrong"**

University in Tennessee, who developed the Little Rip theory.

But Robert Caldwell at Dartmouth College in New Hampshire, who came up with the Big Rip theory, is sceptical. "Right now, we can't distinguish between these cases," he says. "I don't think they are justified in making any conclusion about one model over another."

There's still plenty of time to figure it all out. A Little Rip wouldn't take place for another 100 billion years. ■

## Islands in the sky provide lifeline to plants

CONSERVATION clearly needs towering ambitions. Gardens atop city buildings can be effective refuges for threatened species and help plants colonise the surrounding landscape.

For the past six years, a team of Australian conservationists has been growing critically endangered native plants on the roofs of buildings in Melbourne. The plants are from unique communities on the volcanic plains of Victoria, but are in severe decline because of agriculture.

On roof gardens, threatened species don't have to compete with plants found at ground level, says project leader Nicholas Williams at the University of Melbourne. Moreover, there are no snails or slugs to eat them. The elevation also means the seeds of the endangered plants can drift off in the wind and take root in the wider landscape, Williams says.

The team has been growing two native grasses and 27 wild flower species from the volcanic plains in four 18-square-metre plots on top of Melbourne's Pixel building.

The plants were watered to help them establish, but after that they survived on rainwater. Some species thrived and even spread across the gardens, but others didn't take well to the urban roof environment, says Williams, who will present the findings at the Australasian Plant Conservation Conference next week.

Using green roofs to conserve threatened plants is a great idea, says Andrew Lowe at the University of Adelaide, Australia. But not all species will be able to survive the harsh wind and sunlight on tall buildings, he says. "The other thing is that rooftops are increasingly being used for solar panels, so there might be a bit of a conflict between conservation and renewable energy," he says.

Williams thinks conservation efforts should still focus on maintaining plants in their original environment, but says green roofs can be a useful backup. Alice Klein ■





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## This desert lizard sips water from soggy sand with its feet

THE devil finds work for idle skin. This thorny devil lizard uses its skin as a web of straws to soak up drinking water from soggy sand. The process brings water straight into its mouth, which is useful in a desert – especially if your mouth is so specialised for eating ants that you can't drink water directly.

"Thorny devils are one of the most fascinating species that collect and transport water with their skin," says Philipp Comanns of RWTH Aachen University in Germany. There are microscopic grooves between their overlapping scales, creating a network of drinking straws ending in its

mouth. These draw in water from any part of the body through capillary action, whereby water is pulled along a channel, even against the tug of gravity.

Comanns and his team examined six lizards from Mount Gibson, Western Australia, in the lab to figure out where they get their water from. When they placed them in a water puddle, the lizards could drink through their feet within 10 seconds, as their skin channelled water from their feet into their mouths. "But rain or water puddles rarely occur in their habitat," says Comanns.

The lizards are known to cover their backs with moist sand. When the team placed such sand on replicas of the skin, the straws filled with water, showing that the lizards can use their skin to sip water straight out of the sand (*Journal of Experimental Biology*, doi.org/bsnc).

## Smoking wreaks havoc on our DNA

EVERY 50 cigarettes smoked cause one DNA mutation per lung cell, according to a new analysis.

Smoking has been linked with at least 17 classes of cancer, but this is the first time it has been possible to quantify the molecular damage inflicted on DNA.

Ludmil Alexandrov at Los Alamos National Laboratory in New Mexico and colleagues compared tumour DNA from

2500 smokers and 1000 non-smokers. This allowed them to identify smoking-related mutations. On average, there is one DNA mutation per lung cell for every 50 cigarettes smoked. People who smoke a pack of 20 a day for a year generate 150 mutations per lung cell, 97 per larynx cell, 39 per pharynx cell, 18 per bladder cell and 6 per liver cell, (*Science*, doi.org/bsmg).

Quitting smoking will not wipe these mutations – they leave permanent scars on DNA – but it will prevent more being added, Alexandrov says.

Theoretically, every DNA mutation could trigger a cascade of genetic damage ending in cancer. But we still don't know how likely it is that a single smoking-related DNA mutation will turn into cancer, or which types of mutation are likely to be more malignant.

## Bats smash bird flight speed record

BRAZILIAN free-tailed bats have achieved speeds of more than 140 kilometres per hour in level flight, making them faster than any bird.

"These are the fastest powered flight speeds documented yet in any vertebrate – that is, in bats or birds," says Gary McCracken of the University of Tennessee in Knoxville. "We didn't expect these results, even though the Brazilian free-tailed bats are known for their exceptional fast flight."

Previous studies suggested that birds fly faster than bats, but birds have received more attention, McCracken says. The fastest bird on record for level flight is the common swift (*Apus apus*), which reaches 111 km/h.

The bats are well adapted to their aerial lifestyle. Long, narrow wings with pointed tips help them fly fast and horizontally, and long toe hairs may help judge speed and turbulence (*Royal Society Open Science*, DOI: 10.1098/rsos.160398).

## Listen out for signs of a tumour

SURGEONS have always needed sharp eyes – now they might also need keen hearing.

We can differentiate healthy brain cells from cancerous ones using laser probes and a process called Raman spectroscopy. Now a collaboration between several UK universities and hospitals has given the process an audio output. This means surgeons can listen out for a noise indicating cancer as they operate. Participants in the study could distinguish cells in this way with over 70 per cent accuracy (*Analyst*, doi.org/bsrh).

"We've shown how to give accurate guidance to surgeons in a way that allows them to keep their focus on their scalpel," says Matthew Baker at the University of Strathclyde in Glasgow, UK.

## Same spirals in cells and stars

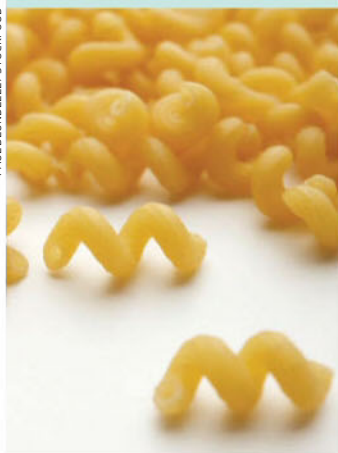
THE conditions differ wildly, but the pasta is the same: the insides of neutron stars and our cells can both form structures resembling cavatappi pasta spirals. This insight could forge new links between the cosmos and life on Earth.

Neutron stars are the ultra-dense cores left behind after stellar explosions. Simulations had shown that their crust can be arranged as a dense layer of shapes – sometimes taking the form of spiral bridges connecting lasagne-like sheets – called “nuclear pasta”.

The parallel with cells came when Greg Huber at the Kavli Institute for Theoretical Physics in California noticed the similarity between the sheets and spirals in nuclear pasta and the endoplasmic reticulum, a network of membranes in cells.

Despite neutron stars being 14 orders of magnitude denser than the constituents of cells, the forces in both interact in a similar way, making the resulting self-assembling shapes nearly identical (*Physical Review C*, doi.org/bsnt).

“Self-assembly is universal,” says Matt Caplan at Indiana University Bloomington. “It lets us bridge a gap between two fields, because we can take the language of biophysics and use it to understand neutron star interiors, and the biophysicists can take computational methods from astrophysics.”



PAUL BLUNDELL / STOCKFOOD

## Solitary bees live off bugs' honeydew before flowers bloom

NEED a sugar fix? When nectar is scarce, bees can tap into another source of sweet stuff – the secretions of other insects.

Sugar-rich honeydew is secreted by sap-sucking scale insects, and may tide hungry bees over until spring flowers bloom.

How wild solitary bees survive before the blooms was largely a mystery, says Joan Meiners at the University of Florida in Gainesville. Unlike colony-building honeybees, solitary bees don't stockpile honey. “There's really not much that's known

about what bees do when there aren't flowers,” says Meiners.

So she was surprised to see many solitary bees hovering around shrubs in California that sported sooty mould – a fungus that thrives on honeydew – while ignoring mould-free plants.

To see if the bees were seeking out the honeydew, Meiners and her team sprayed groups of non-mouldy shrubs with honeydew-mimicking sugar water or with plain water. And to check if the bees were simply after the mould, perhaps as nest-building material,

they sprayed a quick-dissipating insecticide on mouldy bushes to stop new honeydew production while leaving the fungus intact.

More than 100 bees visited each group of sugar-sprayed shrubs – about 10 times as many as for those misted with plain water – and only about 15 visited the insecticide-treated shrubs (*bioRxiv*, doi.org/bsnd). This suggests honeydew is an important food for solitary bees, Meiners says, particularly as climate change begins to shift the timings of bee emergence and peak flower bloom.

## Supernovae sport Mickey Mouse ears

MANY of the glittering shrapnel clouds left behind by the universe's most violent supernovae seem to have bulging “ears”. The cute protuberances are now part of a debate about how these explosions happen.

When a massive star runs out of fuel, it blows up, spewing its atmosphere across space after its core collapses. But how a star tears through its own immense gravity to explode is hotly disputed. The dominant model suggests that a shock wave rips through its atmosphere, boosted by a deluge of neutrinos from the core.

But Noam Soker at Technion-Israel Institute of Technology in Haifa argues that jets of charged particles emitted from the massive star's spinning core punch a path out. His team found that about a third of the remnants of core-collapse supernovae have a pair of ears. Given the ears' sizes and shapes, they estimate that about 10 per cent of all the energy from such explosions goes into inflating these appendages ([arxiv.org/abs/1610.09647](http://arxiv.org/abs/1610.09647)).

But Adam Burrows at Princeton University is sceptical. Jets may play a part, but the shock wave is more important, he says.



RODRIGO FRISCHONE WYSSMANN

## Sailfish samurai hunt better together

COOPERATION makes it happen. Sailfish that work together in groups to hunt sardines can catch more fish than if they hunt alone.

Together, they circle a school of sardines – known as a baitball – and break off a small group, driving it to the surface. They then take turns attacking, slashing at the sardines with their long sword-like bills. Knocking their prey off balance makes them easier to grab.

These attacks only result in a catch about a quarter of the time, but they almost always injure several sardines. As the number of wounded

fish increases, it becomes ever easier for each assailant to snag a meal.

“There's no coordination, no strict turn-taking or specific hunting roles; it's opportunistic,” says James Herbert-Read at Uppsala University in Sweden.

But his team's computer models have shown that even this rudimentary form of cooperation is better than going solo. Sailfish that work in groups of up to 70 capture more sardines each than a lone sailfish would get in the same amount of time (*Proceedings of the Royal Society B*, doi.org/bsnf).



*Professor Dame Carol Robinson*

2015 Laureate for United Kingdom

By Brigitte Lacombe



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# Moving (cyber) house

Political instability is leading some to pledge new allegiances via digital citizenship. Will it transform the way the world works, asks **Sally Adee**

IF YOU live in the UK or US, your sense of national allegiance may have faltered this year. Brexit and the presidential campaign have left many people feeling their country is increasingly unrecognisable. Emigration isn't an easy way out, though. What if you could opt in to the laws of another country without moving there?

Thanks to Estonia's e-residency scheme, you can – and the basic idea is one that's set to grow. Next year, you will be able to file for digital citizenship of Lithuania, and other states are planning similar schemes. One day, perhaps, it will extend to groups other than countries. So what happens when

we all up sticks to the internet?

E-residency is not true citizenship. You won't be able to vote or live in Estonia, and won't have to pay its taxes. Instead, think of it as the right to reside in the Estonian cloud, in exchange for €100 and a few identity checks.

What does that get you? For one thing, unfettered access to the European Union single market, something many UK citizens may want post-Brexit. It is already helping Stanislav Yurin. Based in Ukraine – outside the EU – Yurin uses his e-residency to help him sell paintings internationally. “Ukraine is facing a pretty turbulent economic situation,” he says: PayPal is blocked, and local

payment systems are hamstrung by cumbersome regulations and taxes, he says. “They're hard to use for small businesses.”

“More and more people are becoming global citizens,” says Tavi Kotka, who oversees information security for the Estonian government. “We want to make it easier for them.” To that end, the country recently changed its laws to let its e-residents open online-only bank accounts. In the next couple of years it will extend e-residents' ability to conduct

**“A nation could be the ground you're standing on, or the shared ideologies that bind a group”**

business using Estonian cloud services. Already over 1000 new companies have been established by e-residents.

Estonia doesn't deduct taxes from e-residents, so Yurin need only pay taxes in Ukraine. But e-residency is not a tax haven – in fact, Estonia bills it as the reverse. The country already combs through all its citizens' digital accounts to automatically work out their taxes, and Kaspar Korjus, who directs the e-residency programme, says it will one day provide the same service to its e-residents' home countries.

So what's in it for Estonia? The country's banks and other businesses will offer e-residents a range of paid services, the income from which will allow Estonia to, as one commentary put it, “protect our language, culture and nature, and to pay Estonian citizens by birth decent wages and pensions”.

Estonia has been offering e-residency since 2014 (see map, opposite), and other countries are starting to see the potential. This month Lithuania is set to pass an e-residency law, says Julius Pagojus, the country's vice minister of justice, with registrations to begin in mid-2017.

Lithuania's move is motivated by its diaspora. Some are former citizens, having taken up a new nationality (Lithuania's laws do not allow its citizens to hold more than one passport). The potential effect of Brexit on these people meant the government wanted to offer them a version of citizenship without changing existing laws.

“Our citizens now do not have Lithuanian citizenship but maybe have businesses, real estate or relatives here,” says Pagojus. “We want to use this to help them keep





closer ties to their homeland,” he says, although the scheme will be open to anyone.

Lithuanian e-residents will be able to use any service provided by the state or private sector, and will have access to the EU market. Korjus says he has also been asked by the governments of Finland, Dubai and Singapore to consult for them on setting up their own versions of e-residency. “We won’t be unique for long,” says Kotka.

## Vying for members

Since each e-residency will offer its own benefits, each scheme will be competing with the rest to win members. Estonian entrepreneur Kaidi Rusalepp predicts her life will split in two within 10 years. She will have a physical life where she pays taxes to maintain roads and run local medical services, but her children might study virtually in Azerbaijan, “so some of my taxes will go there to pay for education”, she says.

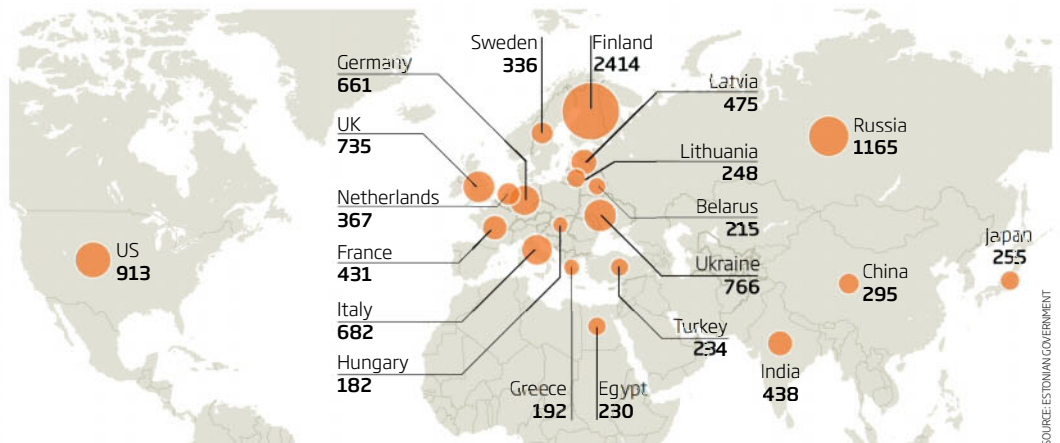
It needn’t stop there, as there’s no reason for e-residency to be something that only countries can offer. “There are two ways of understanding the concept of a nation,” says Korjus. “The ground you’re standing on, or the shared ideologies that bind a group of people.”

Eric Weinstein, who manages Silicon Valley investment firm Thiel Capital, puts it another way. “Some people are ‘hardware’ nationalists – you need to share genetics, you were born on the same soil. But then there are ‘software’ nationalists: they don’t care where someone was born, but it’s important to them to share the cultural programme that makes up their identity.”

Could “software nationalists” bootstrap their own nation? Thiel Capital’s founder, Peter Thiel, has already argued that people might decamp to the sea, space or cyberspace to escape political overreach. What if Silicon Valley created an e-residency scheme of its own? “You don’t have to have

## Digitally domiciled

People across the globe are signing up to become e-residents of Estonia. This map shows applicants from the top 20 countries, but citizens of at least 100 more are joining the scheme



land to exercise de facto sovereignty,” says Lorraine Weekes at Stanford University in California, who is researching the Estonian programme.

Non-territorial nations, she says, might be able to begin exercising control over things until now monopolised by nation states. But can the concept go even further? Could national identities, ported into cyberspace, begin to change our ideas of what is necessary to found a nation state (see “What is a country?”, below)?

## WHAT IS A COUNTRY?

E-residency could lead to the creation of digital-only countries – but what exactly is a country? According to international law, a country is a synonym for a “state” – in the sense of an independent, political entity with a permanent population, a defined territory, a government, and the capacity to enter into relations with other states. There are also “states” that aren’t countries, like Texas.

A nation, by contrast, refers to people who share many markers of identity, but do not have any official sovereignty. One example is the Kurds, who are a distinct ethnic group bound by language and culture, but live under the rule of countries including Turkey, Syria, Iraq and Iran.

Korjus is especially excited by this prospect. “People will choose their citizenship, residency and e-residency according to values. In many transactions, physical space is becoming less important.” To some extent, the divergence between real and virtual populations is already taking place – Estonia’s e-residents are 88 per cent male, for example.

So how far can this separation go? Can you have a purely digital existence, or are some ties to the physical world impossible to cut?

Increasingly, more groups want their own states, from Scottish nationalists all the way to ISIS.

A nation state marries both of these notions to create a political entity. This is probably what you think of when you see the word “country”: it is the planet’s premier political institution.

E-residency (see main story) could create an alternative. It all hinges on whether state-like sovereignty can ever credibly apply to digital-only entities. To some extent, tech giants like Google and Facebook are already effectively sovereign over their users. It remains to be seen if a virtual sovereign can ever take on a real-world state.

In theory, cyberspace has infinite room for all, but Weinstein thinks that conflicts will emerge soon enough. “What does it mean to be an e-Estonian versus an e-Lithuanian? If those two countries go to war, what will happen to e-commerce between those countries?” We don’t know yet, he says. “But we should definitely start looking at these problems.”

William Worster at The Hague University of Applied Sciences in the Netherlands takes a more sceptical view. Some entities, like the offshore outpost Sealand, have claimed to be countries in their own right, but “none have resulted in bringing about a new state in any way”, he says. “Most of them are destined for failure or to linger on as eccentric hobbies.”

Worster doesn’t buy the idea that citizenship can be separated from states. Instead, he thinks states will remain the world’s main political entities by evolving and reinventing themselves – just as Estonia is doing with its e-residency scheme.

In the meantime, e-residency’s star is on the rise. Since the Brexit vote in June, the number of new e-Estonians from the UK has tripled from an average of 22 per month to 70. The digital exodus has begun. ■

# Trials and tribulations

All those interested in progress on chronic fatigue syndrome should unite in the hunt for therapies, says **Esther Crawley**

FOR an illness that causes a lot of misery and suffering, we know very little about chronic fatigue syndrome (CFS), also called myalgic encephalomyelitis (ME).

Those affected by it include many children: one in 100 teenagers miss at least a day a week of school because of it, and probably 2 per cent are missing out on the normal stuff teenagers do. The people I see who are sick with it have disabling fatigue, problems with memory and concentration, and terrible pain.

Yet progress is being hampered because some people dispute its cause and treatment. Some call it a non-illness, and others decry the use of psychological therapy.

The result? Too few people are offered treatment and there is almost no research. Part of the difficulty is that it is not one illness. Both children and adults have different symptom clusters



that may represent different illnesses with different biology, requiring different approaches. This may explain why treatments only work for some.

And although epidemiology shows that CFS/ME is distinct from normal fatigue, people still argue that it is not a real illness because everyone gets tired. But common fatigue is short-lived, has no other symptoms and does not stop you living a normal life. My patients would love to go to school or see their friends, but no longer can.

CFS is poorly studied, but we do know it is heritable, usually triggered by an infection, and that children who get CFS are more genetically vulnerable to it. In teens, hormones are affected: for example, cortisol is low in the morning. We also know of changes that suggest metabolism is different, and that it isn't an individual "bug" that is important

## Sweet 'n' sour

Industry-backed science that disputes sugar's health risks is a problem, says **David Miller**

THE sugar industry seems to have learned well from the tobacco industry. If you want to head off regulation arising from evidence that links your product to ill health, muddy the waters by creating the impression of a controversy where none exists.

A US study highlights this approach, suggesting the

"manufacture of scientific controversy" that casts doubt on the connection between sugary drinks, obesity and diabetes. Of 60 studies analysed, all 26 that failed to find a relationship had links to the sugary drinks industry. (*Annals of Internal Medicine*, doi.org/10/bsm8).

This comes after a September

paper in *JAMA* claimed that the sugar industry "sponsored a research program in the 1960s and 1970s that successfully cast doubt about the hazards of sucrose while promoting fat as the dietary culprit in CHD [coronary heart disease]".

Earlier studies confirm the influence of industry funding on science in relation to sugary drinks and nutrition research.

But it's not just the sugar industry. There is an emerging

and wide-ranging literature on the extent to which science is biased by industry funding in general – including in randomised controlled trials, considered the gold standard in medical research.

In the corporate world, managing science is simply a part of wider strategies to influence government policies to protect profits. Manufacturing scientific controversy is, in other words, part of lobbying.

An upcoming book I co-wrote, *Impact of Market Forces on Addictive Substances and Behaviours*, shows how science is viewed as a lobbying resource by the alcohol, tobacco and sugar

**"In the corporate world, managing science is simply a part of wider strategies... to protect profits"**



in leading to CFS, but the severity of the initial illness it causes.

Some people say that because no precise biological explanation has been found, the illness must be psychological. This is an extraordinary conclusion. There are other illnesses we don't understand, but we don't dismiss them in this way. Even stranger is the idea that because clinicians use behavioural approaches to treat it, we must secretly think CFS is psychological. This is a nonsense: changing behaviour is a potent way to help change biology.

How to move forward? We need huge studies that look at genetics and other underlying biology to understand CFS subtypes. In the meantime, better treatments are needed. That's why we are recruiting people into the largest trial so far of online cognitive behavioural therapy for UK teens and children with the illness.

Patients are desperate for this trial, yet some people are still trying to stop us. The fighting needs to end. Those of us who want to help people with CFS must work together so that this illness is ignored no longer. ■

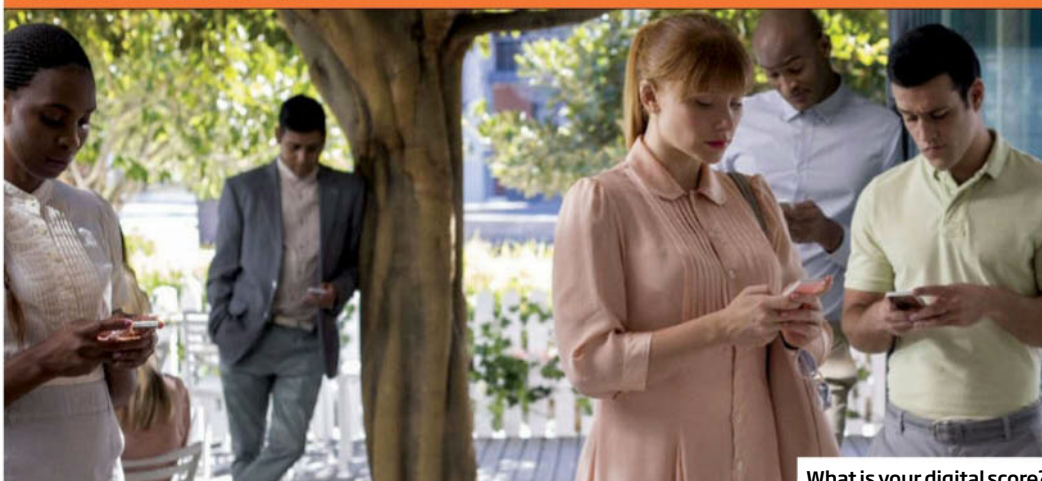
Esther Crawley is professor of child health at the University of Bristol, UK, and consultant paediatrician at Bath Specialist Paediatric CFS/ME service

industries. This includes establishing or funding seemingly independent "scientific" bodies to manage the way in which their products are regulated or debated.

To avoid the manipulation of science and the manufacture of uncertainty over the need for public health action, we need better, more effective independent regulatory bodies with budgets sufficient to monitor and enforce ethical norms and transparency. ■

David Miller, a professor of sociology at the University of Bath, UK, co-founded the Alliance for Lobbying Transparency. See this article online for a declaration of interests: [ow.ly/Hs6O305Ql6Y](http://ow.ly/Hs6O305Ql6Y)

## INSIGHT Social data



What is your digital score?

# You are judged on what you post online

Aviva Rutkin

IN THE first episode of the latest season of the science-fiction TV series *Black Mirror*, everyone is rated on a five-point scale. If your score falls, you are shunned by your peers and by businesses.

Sometimes fiction and reality dovetail. Last week, there was anger over a scheme to offer insurance discounts based on Facebook data – but the idea shouldn't have come as a surprise.

The hullabaloo started when UK firm Admiral Insurance announced firstcarquote, a scheme offering savings on car insurance for people buying or driving their first car. All they had to do was let the company analyse their Facebook profile, generating data that would then be used to calculate a discount according to their personality. Using lists and short sentences, for example, would be seen as signs of conscientiousness and assumed safer driving. Too many exclamation points earned a demerit for overconfidence.

But, after an outcry from privacy activists, Facebook intervened just

two hours before the scheme's planned launch on 2 November, assuring users that it would not allow its guidelines around user data to be violated. "Protecting the privacy of the people on Facebook is of utmost importance to us," said a company spokesperson. Admiral backed down, turning firstcarquote into a simple 10-question survey.

Facebook made the right call, but it would be wrong to focus only on this plan. When you go online, you generate a slew of data about your

**"China has plans to assign every citizen a social credit score that would reflect their trustworthiness"**

personality and lifestyle – and organisations all over the world have been working on more precise ways to sift through the details.

Last year, for example, *New Scientist* reported on several schemes that offer loans based on cellphone records or social media activity. Firms argue that they can quickly get a sense of someone's character using the data, and that such methods show promise

in developing countries or for those without a robust financial history.

China also unveiled plans last year to assign every citizen a "social credit score" – a number, crunched using data from various government databases, that would supposedly reflect the person's trustworthiness. A handful of Chinese companies are now piloting mini-versions of the programme, assigning users scores according to their online activity and encouraging them to share their score with friends as a mark of their good reputation.

Facebook itself may even be interested in finding ways to score users: it has already worked on theoretical projects that aren't too different from firstcarquote. Last year, for example, Facebook patented an "authorisation and authentication" method that could allocate loans according to the credit scores of your Facebook friends. If their average score is above a certain threshold, your loan application will be processed; if not, you're out of luck.

Now that Admiral has scrapped its plans, you might think we have dodged a bullet. But we should expect debate over the issues it raised to crop up again and again and we certainly haven't seen the last of invasive ideas like these. All raise urgent questions about how comfortable we are with such applications of technology. Anyone concerned about their data should buckle up: the fight is far from over. ■

# Machines that listen

A computer model has learned to identify different sounds by binge-viewing two million Flickr videos, finds **Aviva Rutkin**

NOW machines are going on internet-watching sprees too – but they end up with something to show for it. After viewing a year's worth of online videos, a computer model has learned to distinguish between sounds like bird chirps, door knocks, snoring and fireworks.

Such technology could transform how we interact with machines and make it easier for our cellphones, smart homes and robot assistants to understand the world around them.

Computer vision has dramatically improved over the past few years thanks to the wealth of labelled data machines can tap into online. But their listening abilities still lag behind because there is not nearly as much useful sound data available.

One group of computer scientists wondered if they could

them, first detecting the objects in each shot, then matching what it saw to the raw sound.

If it picked up on the visual features of babies, for example, and found they often appeared alongside babbling noises, it learned to identify that sound as a baby's babble even without the visual clue. "It's learning from these videos without any human in the loop," says Vondrick.

The researchers tested several versions of their SoundNet model on three data sets, asking it to sort between sounds such as rain, sneezes, ticking clocks and roosters. At its best, the computer was 92.2 per cent accurate.

Humans scored 95.7 per cent on the same challenge.

A few sounds still give the SoundNet trouble, however. It might mistake footsteps for door knocks, for instance, or insects for washing machines. But more training could help it sort out those fine details.

The study is due to be presented next month at the Neural Information Processing Systems conference in Barcelona, Spain.

"This is like nothing we've seen before," says Ian McLoughlin at the University of Kent in the UK. Most of us communicate primarily using speech and hearing, so such advances could

allow us to speak to machines in a much more natural way. "In human-computer interaction, up to today, we've really just explored vision," McLoughlin says. "We've used our eyes to look at graphics – that's what computers do. But the next dimension is audio."

For example, many of us struggle to get a voice-activated digital assistant such as Apple's Siri to understand what we are saying because it misses words or picks up on irrelevant noise.

With more listening smarts, your assistant could communicate more naturally with you and not be confused if your speech is interrupted by a distracting noise such as an ambulance siren or a dog barking. It could even use such background sounds to understand the context of a situation.

Home security could be another valuable application. Companies such as Audio Analytic in Cambridge, UK, build software that can protect people's properties by listening for threatening sounds – like a window shattering or a smoke alarm blaring. Systems like SoundNet could make that easier.

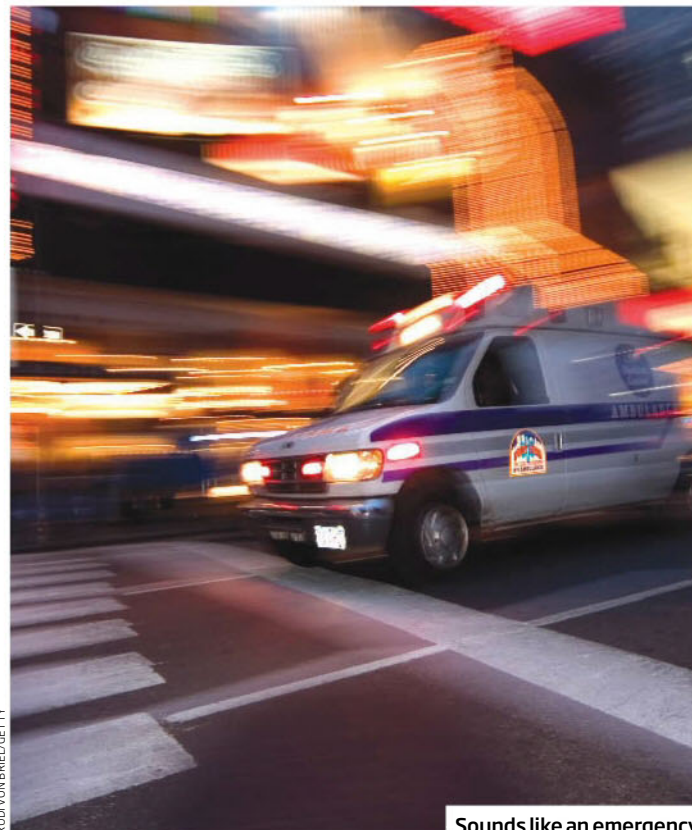
"This would allow you to set up a security system or perhaps interrogate your smart home to find out what's happening in the home," says Mark Plumley at the University of Surrey in the UK. "With recent announcements from Google and Amazon of the Google Home assistant and the Amazon Echo, the idea that a microphone might be around the home and on all the time now is something that could become quite common." ■

**"We mostly communicate through sound, so this could allow us to speak to machines more naturally"**

improve machine listening by piggybacking on the advances made in computer vision.

"We thought: 'We can actually transfer this visual knowledge that's been learned by machines to another domain where we don't have any data, but we do have this natural synchronisation between images and sounds,'" says Yusuf Aytar at the Massachusetts Institute of Technology.

Aytar and his colleagues Carl Vondrick and Antonio Torralba downloaded more than two million videos from Flickr, representing a total running time of over a year. The computer effectively marathoned through



Sounds like an emergency

RUDI VON BRIEL/GETTY



## Fake glasses fool face recognition software

FACE recognition systems have been duped using the oldest trick in the book: a pair of fake glasses.

By printing bespoke patterns on the frames, a team from Carnegie Mellon University in Pittsburgh, Pennsylvania, enabled wearers not only to obscure their identity but also impersonate people who look completely different.

A white man wearing the glasses, for example, was able to pass for Hollywood star Milla Jovovich – in the eyes of the algorithms.

The glasses, presented at a computer conference in Vienna, Austria, last month, work by duping the neural networks used in face recognition systems.

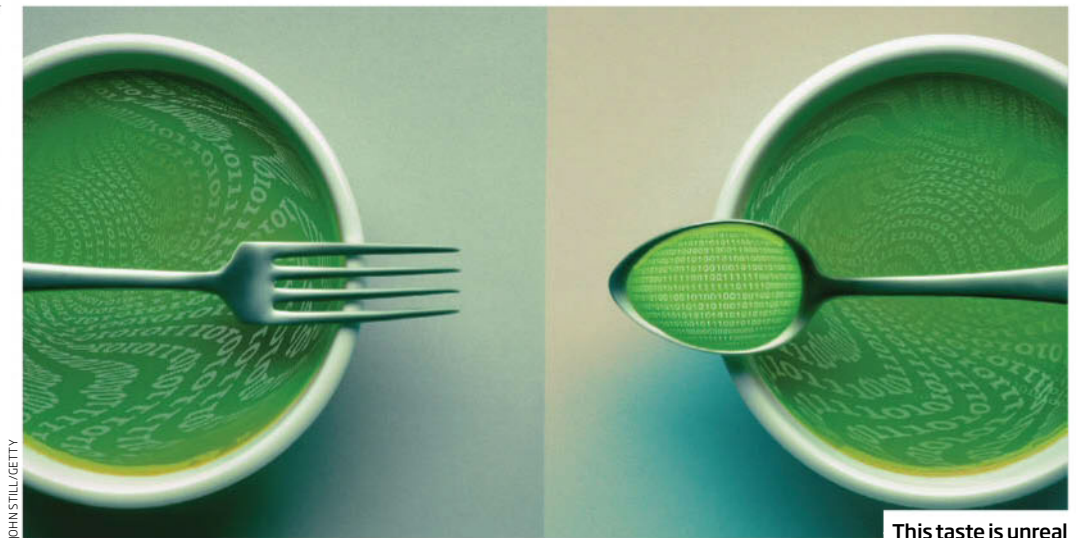
These networks don't rely on the same features that humans use to identify people. They often focus on things like pixel colour to work out who is in the shot. Changing even a small area of the face can completely throw off a recognition attempt.

The patterned frames essentially overlay the wearer's face with pixels that perturb the software's calculations so it misidentifies them as another person in its database.

But a human would miss the ruse. "With some refinement, our glasses would just look like someone had frames with a normal tortoiseshell pattern," says Mahmood Sharif, their co-creator. Timothy Revell ■



Milla Jovovich – or is it?



JOHN STILL/GETTY

This taste is unreal

## Virtual food tech adds bite to VR

Victoria Turk

YOU'RE having dinner in a virtual reality game. You approach the food, stick out your tongue – and taste the flavours on display. You move your jaw to chew and feel the food between your teeth.

Experiments with "virtual food" use electronics to emulate the taste and feel of the real thing, even when your mouth is empty. This tech could add new sensory inputs to virtual reality or augment real-world dining experiences, especially for people on restricted diets.

In one new project, Nimesha Ranasinghe and Ellen Yi-Luen Do at the National University of Singapore made a device that uses changes in temperature to mimic a sweet taste. The user places the tip of their tongue on a square of thermoelectric elements that are rapidly heated or cooled, hijacking receptors that normally trigger the sensation of sweetness. They presented their work at the 2016 ACM User Interface Software and Technology Symposium (UIST) in Tokyo last month.

In an initial trial, it worked for about half of participants. Some also reported a spicy sensation when the device was around 35 °C and a minty taste when it was 18 °C. The researchers envisage such a system being embedded in a glass or mug to make low-sugar drinks taste sweeter and help people cut their sugar intake.

But food isn't just about taste. Also at UIST, a team from the University of Tokyo presented

**"A spoon embedded with electrodes can amplify the salty, sour or bitter flavour of the food eaten off it"**

a device that uses electricity to simulate chewing foods of different textures. Arinobu Nijima and Takefumi Ogawa's Electric Food Texture System places electrodes on the masseter muscle – a muscle in the jaw used for chewing – to give a hard or chewy sensation as you bite down. "There is no food in the mouth, but users feel as if they are chewing some food due to haptic feedback by electrical muscle

stimulation," says Nijima.

To give the "food" a harder texture, they stimulated the muscle at a higher frequency, while a longer electric pulse simulated a more elastic texture. Nijima says their system was best at mimicking the texture of gummy sweets.

Both projects are still in the experimental stage but their goal is to help people with special dietary needs. "Many people cannot eat food satisfactorily because of weak jaws, allergies and diet," says Nijima. "We wish to help them to satisfy their appetite and enjoy their daily life."

Ranasinghe has already experimented with a digital lollipop that emulates different tastes, and a spoon embedded with electrodes that amplify the salty, sour, or bitter flavour of the food eaten off it. He says that a Singapore hospital is planning a long-term study with the spoons to try to reduce sodium intake in its elderly patients.

All this tech could one day be incorporated into a VR headset. "I think the main advantage is to increase the immersion inside the virtual environment," says Ranasinghe. He gives an example: an astronaut could put on a headset, soak in a relaxing view from back home, and have a nice cup of virtual coffee. ■

# Eye, robot

**Sally Adee** meets a robot designed to do cataract surgery

IT'S a real eye-opener. A surgical robot can make the micro-scale movements needed for the delicate procedure of cataract surgery.

Axisis, a small teleoperated system developed by roboticist Chris Wagner and his colleagues at Cambridge Consultants, UK, is designed to cut into the eye with greater accuracy than a human.

Globally, 20 million people a year have surgery on cataracts. They develop when the lens of the eye gets cloudy. To restore sight, a surgeon cuts a small hole in the lens, scoops out the cloudy bit, and replaces it with a plastic lens.

The process requires a steady hand, and a common complication arises if a surgeon accidentally pierces the back of the lens, causing hazy vision.

Axisis is designed to prevent such human errors. It has articulating pincers sticking out of "arms" about the size of drinks cans, with strong, light "tendons" made of the same material that NASA uses for its solar sails. A surgeon uses two joysticks to control the pincers while watching on a screen as they work.

**"It won't let you make the mistake of punching through the back of the lens"**

This is just a demonstration model (pictured below); in the final product, the pincers will be replaced with scalpels.

One benefit of the system is that the software prevents certain boundaries being

breached. "It won't let you make the mistake of punching through the back of the lens," says Wagner.

Surgeons already use robots, such as the da Vinci system, for some operations. But these robots are usually large, often completely enveloping the patient and using long, telescoping instruments. Axisis is scaled down to a small halo around the patient's head.

And while other robots work at small scales – even on eyes – they haven't done cataract surgery. Trials of a system developed by Dutch medical robotics firm Preceyes are ongoing at Oxford's John Radcliffe Hospital and focus on the retina, rather than the lens.

Ophthalmologist Ian Murdoch at University College London says he is interested in the idea that Axisis prevents the back of the lens from being pierced. "This happens in about 0.1 to 0.7 per cent of cases," he says. "If the complication rate is less than this would obviously be great."

But Murdoch wonders whether Axisis provides much of an advantage over existing advanced cataract surgery techniques, such as laser cataract surgery.

Peter Kim, a surgeon at the Children's National Health System in Washington DC, says microsurgical robots are already used in some clinical settings. "I applaud the miniaturisation, but I am not clear on the unmet need and value proposition," he says.

Axisis's creators say cataract surgery is just the start. "It will quickly find more applications," says Wagner. It could, for example, be used in gastrointestinal operations. Put the pincer end of Axisis on an endoscope and it could solve minor problems – like removing polyps – then and there. ■



## Gaming vs gambling

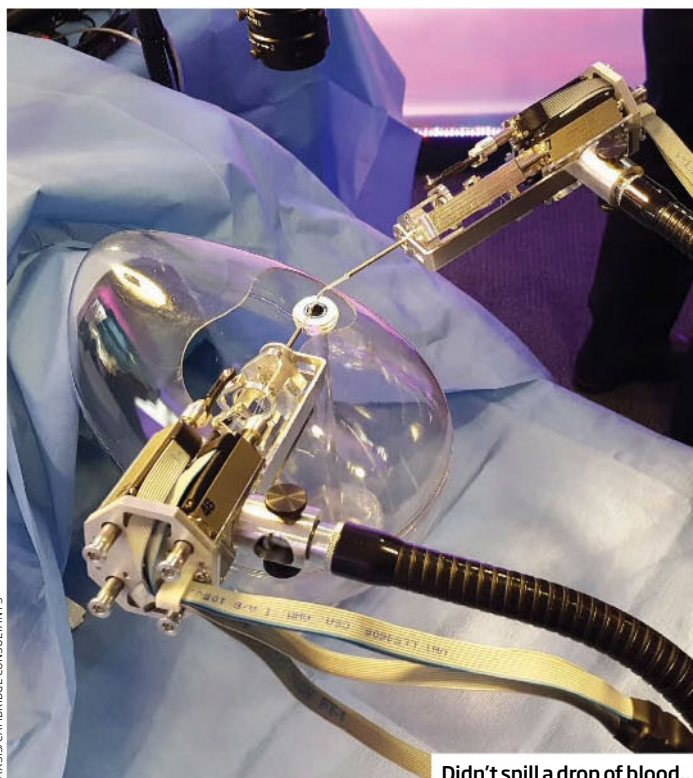
A survey of 19,000 people in the UK, US, Canada and Germany suggests that playing online games is far less addictive than gambling. Just 0.5 per cent of the general adult population reported significant distress at their gaming habits (*The American Journal of Psychiatry*, doi.org/bsnh). The first large-scale research into the prevalence of "internet gaming disorder" also found no clear link between potential gaming addiction and health.

**"We don't need to worry about automation or robots at all"**

Inventor **James Dyson**, speaking at the launch of the Dyson Institute of Technology, says automation "increases the number of more interesting jobs for people".

## Electrical healing

Self-healing gadgets are inching closer. A team at the University of California, San Diego, has made magnetic "ink" that fixes itself after being damaged. In one demonstration, the group printed a circuit out of the ink and cut it with scissors. Within seconds, the two ends bonded back together. The ink could also be used to make self-healing batteries and sensors (*Science Advances*, doi.org/bsnb).



Didn't spill a drop of blood...





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## Peak power

HOKUSAI, eat your heart out. Here, the iconic Japanese artist's woodcut waves are transformed into the real deal.

In the North American autumn, Arctic air meets warmer air from the south, creating the perfect conditions for storms. Wind rages around all of the Great Lakes at this time of year, but Lake Erie, pictured here, is the shallowest and contains the least water. This means its waves are typically the biggest as it is more easily influenced by the wind.

As the wind blows, the waves start to build a beat, rhythmically sloshing back and forth along the lake's roughly east-west axis, and growing in height as they do.

This towering wave was captured by photographer Dave Sandford, who lives in Port Stanley on the Canadian side of the lake, around 90 kilometres from its US shoreline. "The day started out overcast and I was initially taking pictures stood in the water. You really take a beating from the waves and it's only possible to bear the cold for so long," says Sandford. "The final picture was taken crouching down by the water's edge."

The water is darkened by mud and sand churned up by the ferocious currents. As the waves oscillate, the lake can become as much as 2 metres deeper at one end, while dropping 2 metres at the other. Waves violently smack one shoreline before the pattern reverses. When the conditions are just right, a seiche - or standing wave - can occur.

"When you're stood there, it looks like an ocean," says Sandford. "You can't see the other shoreline in the distance, just never-ending water and waves." Timothy Revell

## Photographer

**Dave Sandford**

[davesandfordphotos.com](http://davesandfordphotos.com)

# HELP FOR HEROES

Teaming the battery with a nifty sidekick could transform how we use energy.

Mark Harris reports

**A** GAINST the backdrop of the Nevada desert a gigantic factory is taking shape. Look at the artist's impressions of the finished building and you could mistake it for a Martian colony, its ranks of solar panels stark against the reddish dirt. But this is the Gigafactory, a sprawling edifice covering around 600,000 square metres. Here, electric car company Tesla Motors plans to make a single component of its vehicles: the battery.

A good rechargeable car battery will set you back around \$10,000, for a product that is toxic, degrades substantially after a few years and must be carefully designed to avoid catastrophic overheating. The Gigafactory represents Tesla CEO Elon Musk's drive to make better batteries and so realise his dream of affordable electric cars.

Others are similarly exercised. Samsung's recent woes with exploding batteries in its Galaxy Note 7 smartphone caused it to recall all the devices and cease production. "It will cost us so much it makes my heart ache," said Koh Dong-Jin, president of Samsung's mobile business. Better, cheaper batteries are top of the wish list for almost any technology that's not powered by fossil fuels.

Yet as Musk and others are finding, it's proving a long, hard road. Might there be a better way? That's the claim of researchers championing a long-overlooked device to store and supply energy. They think it could actually stand more of a chance of delivering the power we need, how we need it – and so revolutionise the way we use energy. Is it time to look beyond batteries?

Rechargeable batteries store energy by

performing a reversible chemical reaction in which ions are stored in and flow between positive and negative electrodes. The right materials, such as the lithium compounds common to both Tesla and Samsung's batteries, can store lots of energy, but are slow to charge and discharge, and heat up when they do. What exactly caused the Note 7 fault is not yet clear, but lithium ion batteries need tiny separators to keep components apart. If these are poorly designed or damaged they can fail, creating a short circuit that heats and damages other parts of the battery causing a runaway reaction. Such safety concerns, plus the sheer cost of lithium batteries, have long had chemists casting around for something better.

But chemistry isn't the only way to store electric charge. In devices known as capacitors, energy is physically stored in an electric field between metal electrodes. Capacitors are sprinters to the battery's long-distance runner, charging and discharging in a blink, and doing this over and over again without their performance suffering. They are already used to power the flash on a camera.

But you can't run a car on a camera flash. A kilogram of petrol contains about 4000 Watt hours of useful energy, 30 times as much as the batteries in Tesla's current crop of vehicles. Traditional capacitors hold 1000 times less again, just 0.1 Watt hours per kg. If your car could drive 500 km on a tank of petrol, it would run little more than 16 metres using the same weight of capacitors.

It's unthinkable, then, that a traditional capacitor could ever compete with a battery. But many have had that exact thought –

even Musk. "If I were to make a prediction, I'd think there's a good chance that it is not batteries but capacitors" that will deliver a breakthrough, he said in 2011. In that reading, it's just a case of guiding the continuing evolution of the capacitor.

That evolution stretches back to 1966, when Robert Rightmire at Standard Oil of Ohio was part of a team considering the future of fuel storage. He knew that the charge a capacitor could store depended on the surface area of its electrodes. So why not make these surfaces more spongy, the better to cram in charge? He produced a capacitor where the electrodes were coated with thin layers of carbon chemically punctured with millions of tiny holes. This so-called activated carbon is typically used for jobs like decaffeinating coffee, and has an internal area about 100,000 times larger than its outside surface. And it worked. Rightmire's "supercapacitors" stored 10 times as much energy as traditional capacitors.

## Ditch the coconuts

By the 1990s, small supercapacitors had become a commercial reality. They provided instant, short-lived back-up power to computers if the mains supply failed, so they could shut down safely. That's still a long way from powering a car. For a long time, not much changed. This was partly down to the curious source of that spongy carbon: coconuts.

"It's pure luck," says Aaron Feaver, chief technical officer at EnerG2, an energy storage company based in Seattle. "The coconut didn't evolve to be an ultracapacitor electrode" ➤







## "Badly designed batteries can explode, but that's the least of their problems"



material, but it just happens to work pretty well." Leftover husks are heated to 600 °C in an oxygen-free oven to get rid of all elements except carbon, a process known as pyrolysis. The carbon is then treated with chemicals to etch in the tiny pores.

Coconuts were so cheap and convenient a source of carbon that no one thought much about other possibilities. At some point in the late 1990s, supercapacitors were rebranded "ultracapacitors", but the principle remained the same.

And they've continued to find new uses. Some wind turbine companies use them as an

emergency alternative to batteries. Turbine blades need to be constantly adjusted to face the wind. If their electricity supply fails, the blades must quickly return to a neutral position to avoid strong gusts damaging or even destroying the turbine. That calls for a short power splurge – what ultracapacitors excel at. Plodding batteries are heavier and eventually need replacing. "Once you've put something into a turbine you're not going to want to go up and service it. You just want to forget it," says Kim McGrath from Maxwell Technologies, an ultracapacitor manufacturer.

That special ability of ultracapacitors to provide a short zip of power is useful in other places too. In China, fleets of hybrid diesel buses are equipped with ultracapacitors that charge up swiftly from regenerative braking systems, and later accelerate the bus until the diesel engine can take over.

Meanwhile, material innovations suggest ways to store more juice in capacitors. In the mid-2000s Joel Schindall, John Kassakian and Riccardo Signorelli at the Massachusetts Institute of Technology began to explore whether other types of carbon might perform better than the coconut husks. It just so happened that a nearby lab housed Mildred Dresselhaus, known as the "queen of carbon science" for her work on exotic forms of the stuff. She helped the trio build a forest of tiny carbon nanotubes, cylinders

of pure carbon 10,000 times smaller than a human hair, that could boast over 2000 square metres of area per gram.

Ultracapacitors using nanotubes have gone on to be a success, notably through FastCap Systems, a firm founded by John Cooley, also from MIT. FastCap have produced capacitors that will help power NASA missions to Venus and deep space. Its best model can hold 10 per cent of the charge of one of Tesla's batteries, about twice as much as the next best commercial product.

Such nanotube designs are expensive, and in general ultracapacitor capacity is still not enough to put the Gigafactory in jeopardy – but that might not be the point. "We do not ever expect ultracapacitors to be the primary energy storage device in an electric vehicle," says Cooley. But if they can play the role of trusty sidekick, reducing the peak power load on tired batteries – the very thing that shortens their life – we could all benefit.

How so? While the idea of driving an electric car may or may not appeal to you, no one can ignore the problems facing electricity grids. We want energy supplies to be not just affordable, but reliable and green too. Ticking all those boxes is getting tougher, even for nations with highly developed economies. In October, for example, the UK fell out of the top 10 nations in the World Energy Council's Trilemma Index, an energy security ranking.

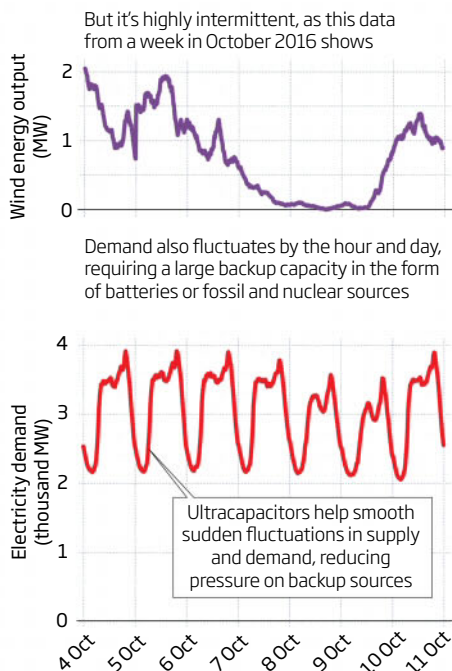
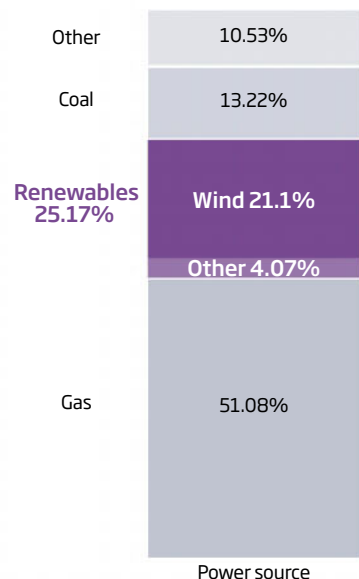
We have become serious about cheap green energy in recent years; renewables accounted for two-thirds of new generating capacity in the US last year, and over half worldwide, according to the United Nations. But on the one hand, demand for electricity varies widely and on the other, the supply of energy from renewables is intermittent. The wind doesn't always blow and the sun doesn't always shine (see "Supply and demand", left).

This problem has been met with the concept of the smart grid, where networks of sensors and switches constantly monitor and adjust the flow of energy from all sorts of generators to consumers. But this inevitably means storing the electricity, and those sluggish batteries are once again where we trip up.

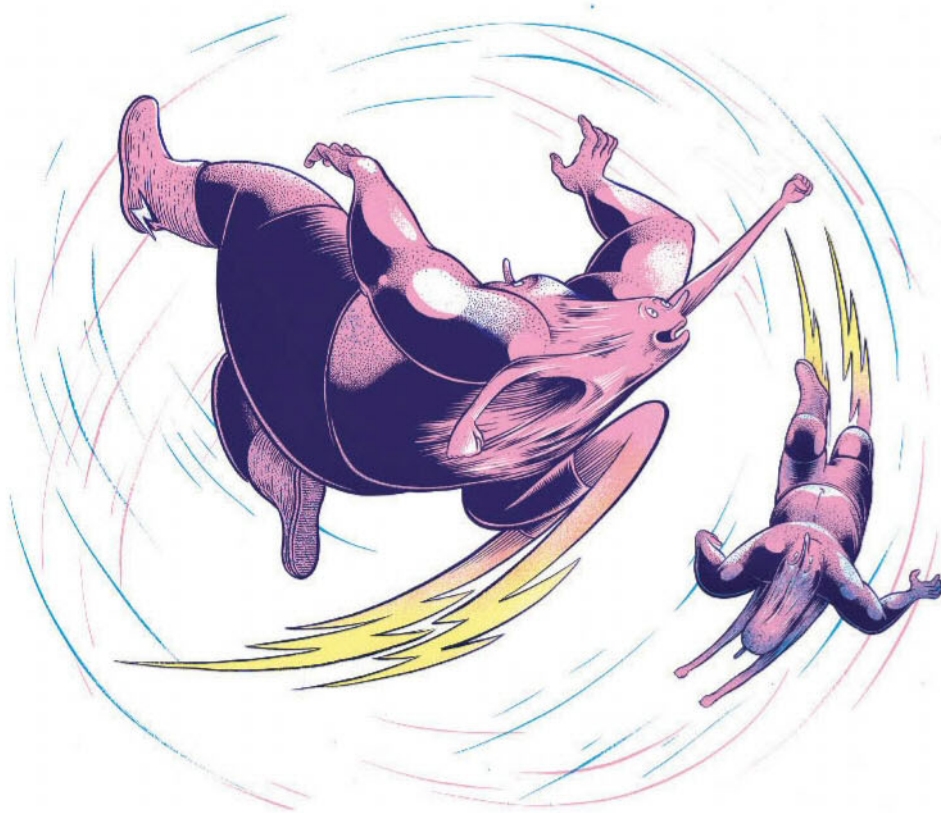
Using batteries as the sole storage medium isn't ideal for two reasons. First, constant charging and discharging shortens their life. Second, batteries can't release all their energy quickly, so grids need excess battery capacity to cope with short surges in demand over and above normal fluctuations. Adding ultracapacitors instead of supersizing the battery is a vast improvement. "The net effect is a reduction in the upfront expenditure and

## Supply and demand

In Ireland, wind power now accounts for almost a quarter of energy supply







lower operating costs," says McGrath. "And the technology has now gotten to the stage where it blows the market open for us."

This year, Maxwell deployed two test ultracapacitor storage systems. One is in North Carolina, where the ultracapacitors are connected to a photovoltaic solar farm and a battery with a saltwater electrolyte. When the solar panels' output fluctuates due to passing clouds, the ultracapacitor goes to work. It can quickly supply nearly three times the power of the battery pack, but is exhausted in a couple of minutes. At that point, the battery, which holds about 40 times as much energy, steps in. The test is being carried out by Duke Energy, a utility company in the US with more than 7 million customers. It says the system is 10 to 15 per cent cheaper than a battery-only setup. "It should also slow down any degradation of the battery," says Duke's Randy Wheelless.

Wind power is just as intermittent as the sun, and in the less balmy climes across the Atlantic it is the go-to renewable power source.

***"It would be unwise to bet against ultracapacitors ousting batteries entirely"***

In Ireland, wind power accounts for almost a quarter of electricity generation, and the country wants that to be 40 per cent by 2020. It is here that the second test is taking place, in an experimental smart grid in Tallaght, near Dublin. Ultracapacitors connected to local government office buildings have proved able to compensate for changes in frequency of the electricity supply within a fraction of a second. Klaus Harder of FreqCon, a German firm that supplied the ultracapacitor-battery hybrid storage unit, says the ultracapacitors are so far living up to their promise.

FreqCon is planning to test a larger ultracapacitor-battery unit on the west coast of Ireland soon. But there is an ongoing challenge for the technology. Batteries may be imperfect, but they are still gradually improving. Ultracapacitors need to keep pace by increasing their capacity in tandem.

There is plenty of scope for that. Firms like EnerG2 say they will further improve the technology by using new sources of carbon to coat the electrodes. "Coconuts are cheap but they come with lots of natural contaminants and the activation process is toxic and expensive," says Feaver. EnerG2 designs its own carbon based polymers, similar to

the resins used for laminating plywood. It then pyrolyses and activates them using a simpler, greener process.

EnerG2's carbon can also be tailored to different types of ultracapacitor. Those designed to quickly stop and start a car's petrol engine to improve fuel efficiency need a quick burst of power, but for smoothing a domestic solar panel's output, capacity might be more important than speed. Coconut carbon has pores whose size matches common electrolytes such as ammonium salts. But by adjusting its chemistry, says Feaver, EnerG2 can produce carbon with pores to match electrolytes designed for high power density, high energy density, or any combination of the two.

## Practically invincible

Some think there could be greater leaps ahead if we break our attachment to carbon. William Dichtel, a chemist at Northwestern University, Chicago, has developed polymer networks called covalent organic frameworks to work directly in ultracapacitors without needing pyrolysis. His team succeeded in producing a porous ultracapacitor material that approached the performance of a nanotube device but potentially at a fraction of the cost. "The caveat is that we're chemists doing basic research, not Tesla trying to put this in a car in a profitable fashion," says Dichtel.

There are concerns that exotic polymer-based ultracapacitors might not have the longevity of today's carbon systems. True, these ultracapacitors are not invincible, says Feaver. "But when you compare them with batteries, they might as well be." The battery in a cellphone or electric car is designed for 1000 charge-discharge cycles, whereas even Dichtel's experimental ultracapacitor was stable for at least 10 times as many cycles.

Ultracapacitors have come so far from their humble beginnings that it is tempting to wonder if they might graduate beyond their sidekick role and oust batteries entirely. We're far from that day, but perhaps it's unwise to bet against it ever arriving. We know that Elon Musk toyed with a PhD studying ultracapacitors before quitting for his first Silicon Valley start-up. And Tesla Motors' patents still make tantalising references to ultracapacitors. The man once so enamoured with ultracapacitors hasn't entirely lost faith, then. Maybe they are still evolving behind the doors of that huge factory in Nevada. ■

Mark Harris is a technology journalist based in Seattle, Washington



# Reputation is everything

Honour culture is more familiar than you think, and that could be a problem, finds Emma Young

**M**UBEEN RAJHU pleaded with his sister, Tasleem, to end her relationship with a Christian man because it brought shame on the family. Then he put a bullet in her head. “I had to do it,” Rajhu told a reporter earlier this year. “There was no choice.” Many of his neighbours in Lahore, Pakistan, agreed: Rajhu deserved praise for doing the right thing, they insisted.

Most of us cannot fathom the kind of thinking that condones “honour” killings, when fathers and brothers murder loved ones, typically women, in the name of reputation. We tend to associate this strict code of honour with countries like Pakistan, Afghanistan and Somalia, and with extreme religious beliefs. But Ryan Brown thinks it is more familiar than you might think.

Brown, a social psychologist at the University of Oklahoma in Norman, studies “honour cultures” – ones characterised by a deep concern for reputation and a sense of being duty-bound to retaliate against anything perceived as a slight. His research in the US south shows that it is alive and well

among millions of people there, and potentially in other Western countries too. He also argues that honour culture is an important cause of all kinds of problems, from elevated murder rates to a reluctance to address mental health issues. Can he be right?

## Insult to injury

Anthropologists and social scientists distinguish between what are sometimes called dignity cultures and honour cultures. Dignity cultures value people simply by dint of being human. Here, people seldom turn violent at the first hint of a challenge to their reputation, instead ignoring it or perhaps seeking redress in the courts.

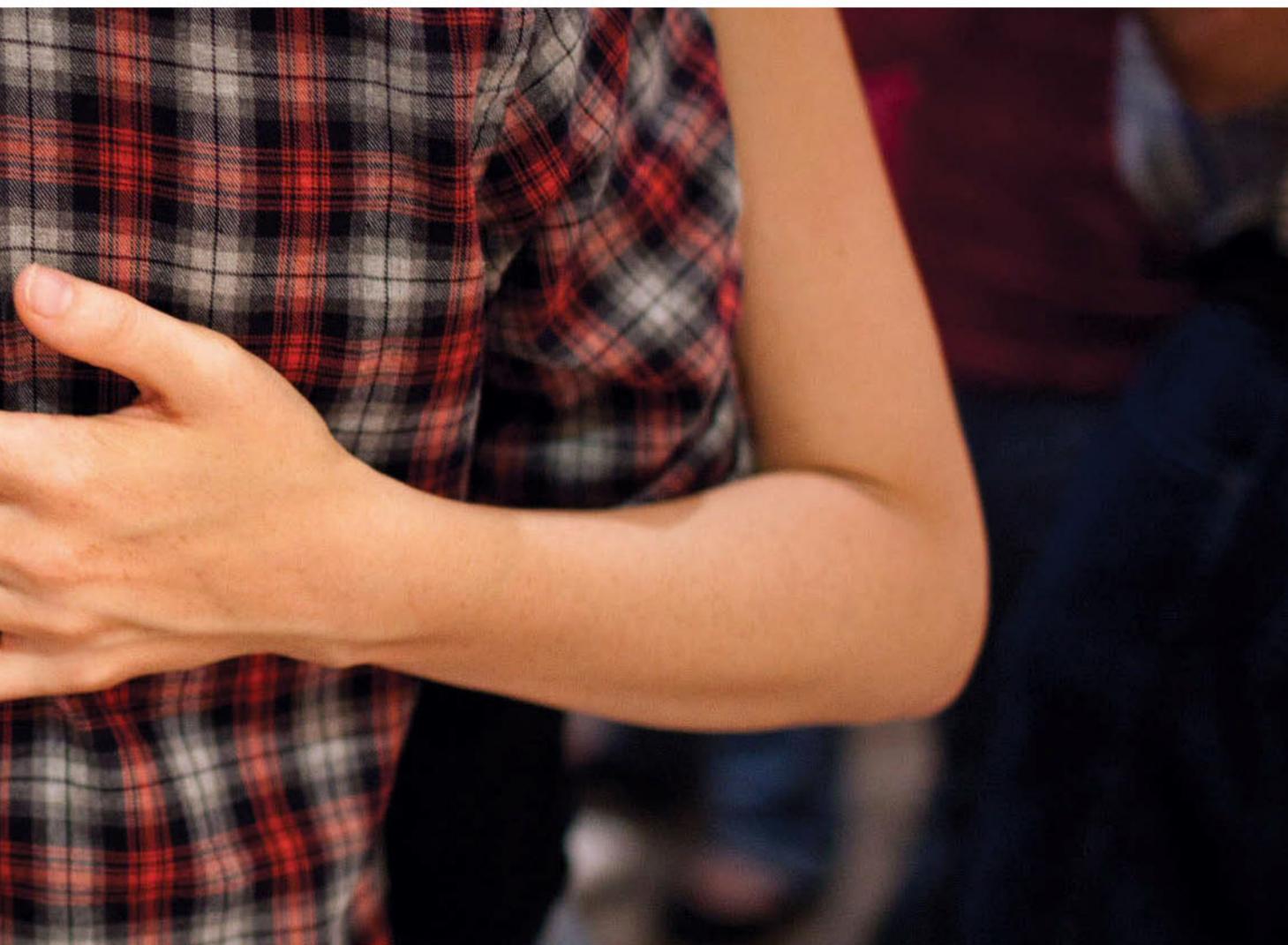
In honour cultures, on the other hand, your value rests on your reputation, the impulse to defend it is heightened and individuals are expected to avenge insults themselves. There are plenty of historical precedents: think of the duelling tradition in the Old West or in Europe, from the chivalrous knights of medieval times right up until the 18th century.

Honour cultures are also characterised by contrasting gender expectations. For women, the key requirements are to be faithful and protect one’s virtue. Men should be strong, self-reliant and intolerant of disrespect. They must earn this reputation, and then defend it – even if that requires violence.

One of the clearest signs of an honour culture, then, is that people are likely to react violently to insults. A landmark social psychology study carried out two decades ago revealed this as an intriguing point of difference between the north of the US and the south – defined by the US Census Bureau as the 16 states from Texas to Delaware, including the eastern seaboard, below the Mason-Dixon line. When Richard Nisbett at the University of Michigan and Dov Cohen at the University of Illinois at Urbana-Champaign assessed how male college students responded to annoyances and insults, such as being bumped into and called an “asshole”, they found that those born in the south reacted more aggressively than northerners.

Nisbett also found that “felony” homicides –





BRENDAN SMIALOWSKI/NT/REDUX/EVINE

killings committed during another crime – are equally common in the north and south, whereas “argument-based” homicides – killings that follow a disagreement or insult – are significantly more common in the south. In both cases, this clear geographical difference held only for white people.

Brown, who was himself born and raised in Alabama, had suspected that these attitudes might be rooted in religious fervour. The south is known as the “Bible Belt”, after all, and countries with much stricter honour cultures, such as Pakistan, are highly religious. However, repeated studies both in the US and elsewhere have found no link between a person’s religiosity and how much they endorse honour-culture attitudes.

Instead, honour cultures seem to develop wherever there is severe economic insecurity and a degree of lawlessness. “When these factors come together, we believe honour culture is a sort of natural byproduct, because reputation is a way you protect yourself when no one else is coming to your aid,” says Brown.

So why is honour culture more prevalent in

the US south, and particularly among whites? In his new book, *Honor Bound*, Brown argues that the underlying ideology arrived in the early to mid-16th century, brought by Scots migrating via Northern Ireland. Many of these Ulster Scots were herders, and having first settled the Appalachians, they then moved south and west, where the ecology is more suitable for herding than farming. Here, the argument goes, the chronic threat of livestock

### **“States that most strongly endorse honour ideology have higher suicide rates”**

theft meant that a culture of honour-based violence conferred an economic advantage. Over the centuries, the attitudes these migrants brought have been diluted, but still they persist – and for Brown, at least, they have a big impact on people’s behaviour.

Brown has led several studies of how honour ideology manifests itself, in each case attempting to strip out the effects of poverty

### **Honourable thinking prizes politeness but spurs violence**

and other factors that could skew the results. In one, he and his team looked at US school shootings and found roughly twice as many per capita in “honour states” – defined by researchers as those ranking in the top half for endorsement of honour-based values (see “League of honour”, page 35) – than non-honour states. Honour states generally have laxer gun control laws, but the researchers adjusted for this. Besides, says Brown, those laws reflect honour ideology, which considers that individuals have a right – even a duty – to defend themselves and their reputation.

Given the gender divide in honour cultures, you might expect higher levels of violence against women in them than in other societies. Sure enough, rapes are significantly more common in honour states – but, again, only for white perpetrators. Likewise, the rates of domestic homicide among whites are 62 per cent higher in honour states than elsewhere, Brown and his colleagues have ➤

## "It pays to be well mannered in a society where an insult could cost you a beating"

found in research they hope to publish soon. There's no study yet linking a man's level of endorsement of honour-related values to his likelihood of committing rape or murdering his wife. But men who score higher on ratings of honour ideology than other men are more prone to sexually objectify women and display stronger beliefs that men should have power over women.

### Show no weakness

There has also been precious little work on the persistence of honour culture in modern Western societies outside the US south. We know it is found in gang cultures everywhere, for example, and it may exist beyond gangs in parts of Europe. But it has yet to be studied extensively in such places.

In the US, honour ideology is strong in the growing Latino population too, and their particular take on it may prove to be influential over the next 50 years, Brown predicts. But, for now, he argues that his work reveals what many might see as a surprising influence on life today in white communities across the south.

Brown has recently investigated the connection between honour culture and mental health. A 2014 study showed that people who strongly endorse honour-related values are especially concerned that seeking help for mental health problems would indicate weakness and harm their reputations. This makes a skewed sort of sense. In an honour culture, "if you need help, that suggests you are mentally fragile and weak", says Brown. "But going to get help would be a second blow: 'Not only do I have a need, but I can't handle that need on my own.'" Such results chime with another of Brown's findings: that honour states not only have higher levels of depression and lower use of antidepressants than other states, but also have higher suicide rates, even after controlling for other relevant factors.

So far, so bleak. But the influence of honour culture isn't entirely negative. The premium placed on loyalty might explain why soldiers from southern states fighting in the second world war were more likely than those from the north to win the Congressional Medal of Honour, typically given to those who died trying to save their comrades. "That's not just saying: 'We care about loyalty'," says Brown. "It's demonstrating it in the ultimate way."

For Cohen and Nisbett, honour culture also helps to account for the famous politeness of southerners. After all, it pays to be well

**In honour cultures, men are expected to fiercely defend their reputations**



ELI REED / MAGNUM PHOTOS

mannered in a society where an insult could cost you a beating. But that only holds up to a point. In one study, Cohen and colleagues brought northerners and southerners together for a simulated art therapy session, during which they were constantly pestered by someone they thought was another volunteer but was actually a researcher. "The northerners consistently showed their annoyance and then plateaued in their anger,"

says Cohen. "Southerners, on the other hand, were polite, polite, polite – and then you got a big explosion."

He thinks this style of interaction contributes to violence in honour cultures because it prevents people from openly telling others that they are crossing the line. Children grow up learning to behave like this, which might explain the persistence of higher rates of adult violence centuries after the arrival of



PETER BOHLER / REDUX / EYE/VIEW

**Lax gun laws in some US states may reflect honour-related values**





## THIS MEANS WAR!

We all care about what other people think of us, but some societies take reputation more seriously than others. If “honour culture” exerts a particular sway over the southern states of the US, as some researchers suggest (see main story), there may be global repercussions whenever this ideology spills over into US foreign policy.

Dov Cohen, a psychologist at the University of Illinois at Urbana-Champaign, has found that members of Congress from the south argue for greater military spending, and were more likely to have supported the first Gulf war after Iraq invaded Kuwait in 1990.

Likewise, a study of 36 US presidents between 1816 and 2001 suggests a relationship between the endorsement of honour-based ideology and war: Allan Dafoe at Yale University and Devin Caughey at the Massachusetts Institute of Technology found that southern presidents were twice as likely to use military force in international disputes as their peers from elsewhere.

When force was used, they found, it tended to be exerted for twice as long with a southern president in charge. And the US was three times more likely to win a conflict under a southern leader.

Ryan Brown at the University of Oklahoma, who studies honour culture in the US south, argues that this is not down to some general level of aggression in the south. Instead, he says, it happens partly because an honour-oriented leader believes that if you make a threat, you have to follow through. Not doing so will damage your reputation even more than failing to make a threat in the first place.

“If you don’t threaten an honour-oriented person - don’t threaten their sense of honour, don’t insult them - they are, in fact, more likely to be polite,” says Brown.

announced his candidacy, about Mexicans “laughing at us”, says Brown. “To somebody who is steeped in the ideology of honour, very few things are more repugnant than being laughed at, whether that’s personally or as a family, community or nation.”

Of course, no one thinks honour culture is the only factor that can explain differences between the US north and south, least of all Brown. But if it has a big influence on behaviour, should we be looking to shape it to alleviate some of the problems it has been linked to? Collin Barnes, a psychologist at Hillsdale College in Michigan, thinks not. “The alteration of a culture on social scientific grounds is not an activity I’d wish to associate with,” he says.

Although he has worked with Brown in the

past, Barnes now has reservations about this research. It is difficult to support claims of cultural causation, he says, because even when researchers control for confounding factors, attributing behavioural differences to one construct requires a heavy burden of evidence. In this case, Barnes is not convinced that burden has been met. Take Cohen and Nisbett’s landmark study. “It is not too much to ask that the result of this experiment and others like it be replicated,” says Barnes. “To my knowledge, no such attempt has been made, and this makes me hesitant.”

Barnes also thinks that the methods of social psychology tend to oversimplify reality. In that sense, his reservations don’t apply exclusively to research into honour culture.

For his part, Brown is well aware of the pitfalls of attempting to reduce the workings of human societies, in all their glorious messiness, to simple answers. Even so, he and Barnes agree that allying such research with lessons from history and experience can improve our understanding of how culture influences thinking and behaviour.

And although he does try to teach his sons to avoid taking offence too readily, Brown seeks only to understand this aspect of southern culture, not to change it. “These are my people. It’s part of my cultural heritage,” he says. “I’m an insider saying: ‘Let’s be honest about our culture. Let’s turn over the rock and see what’s on the underside.’” ■

## LEAGUE OF HONOUR

Where in the US do people care most deeply about their reputation? Social psychologists have compiled a league table based on surveys designed to tell them which states most strongly endorse the values of “honour culture”.

### Top 5

South Carolina  
North Carolina  
Alabama  
Georgia  
Arkansas

### Bottom 5

Hawaii  
Rhode Island  
Wisconsin  
Minnesota  
North Dakota

the Ulster Scots, according to Cohen. Another explanation for the persistence of honour cultures could be the way that honour ideals are built into gender definitions. “What it means to be masculine or feminine has real staying power and persists long after the conditions that might have produced those ideals and values have dissipated,” says Brown.

Today, the US is far from lawless, but economic uncertainty lingers for many. Brown thinks this could help explain support for Donald Trump, whose presidential campaign rhetoric played heavily on the idea that the nation’s reputation has crashed. Brown’s research indicates that honour-oriented people tend to be more sensitive than others to the idea that they might be “taken advantage of” by immigrants.

What’s more, in unpublished work, he and colleagues looked for evidence of honour ideology in the language used by candidates in recent presidential elections, and found it to be prevalent in the rhetoric of several Republican hopefuls. “Some sell it better than others, and I think Trump sold it pretty well,” says Brown. “He talks a lot about respect.” Take his comment, made in June 2015 when he

Emma Young is a writer based in Sheffield, UK

**W**hen she first saw the necklace, Genevieve von Petzinger feared the trip halfway around the globe to the French village of Les Eyzies-de-Tayac had been in vain. The dozens of ancient deer teeth laid out before her, each one pierced like a bead, looked roughly the same. It was only when she flipped one over that the hairs on the back of her neck stood up. On the reverse were three etched symbols: a line, an X and another line.

Von Petzinger, a palaeoanthropologist from the University of Victoria in Canada, is spearheading an unusual study of cave art. Her interest lies not in the breathtaking paintings of bulls, horses and bison that usually spring to mind, but in the smaller, geometric symbols frequently found alongside them. Her work has convinced her that far from being random doodles, the simple shapes represent a fundamental shift in our ancestors' mental skills.

The first formal writing system that we know of is the 5000-year-old cuneiform script of the ancient city of Uruk in what is now Iraq. But it and other systems like it – such as Egyptian hieroglyphs – are complex and didn't emerge from a vacuum. There must have been an earlier time when people first started playing with simple abstract signs. For years, von Petzinger has wondered if the circles, triangles and squiggles that humans began leaving on cave walls 40,000 years ago represent that special time in our history – the creation of the first human code.

If so, the marks are not to be sniffed at. Our ability to represent a concept with an abstract sign is something no other animal,

not even our closest cousins the chimpanzees, can do. It is arguably also the foundation for our advanced, global culture.

The first step to check her theory was to fastidiously document the signs, their location, age and style, and see if any patterns emerged. For this, von Petzinger would have to visit as many caves as she could: archaeology's focus on paintings of animals meant the signs were often overlooked in existing records.

It wasn't easy or glamorous work. Gaining access to caves in France, where a lot of Stone Age art is located, can be devilishly complicated. Many are privately owned and sometimes jealously guarded by archaeologists. For the full set of symbols, von Petzinger also had to visit many obscure caves, the ones without big, flashy paintings. At El Portillo in northern Spain, all she had to go on was a note an archaeologist made in 1979 of some "red signs"; no one had been back since. At first, von Petzinger couldn't even find the entrance. Eventually, she noticed a tiny opening at knee level, trickling with water. "Thank God I'm not claustrophobic," she says. After 2 hours sliding through mud inside the mountain, she found two dots painted in pinkish ochre.

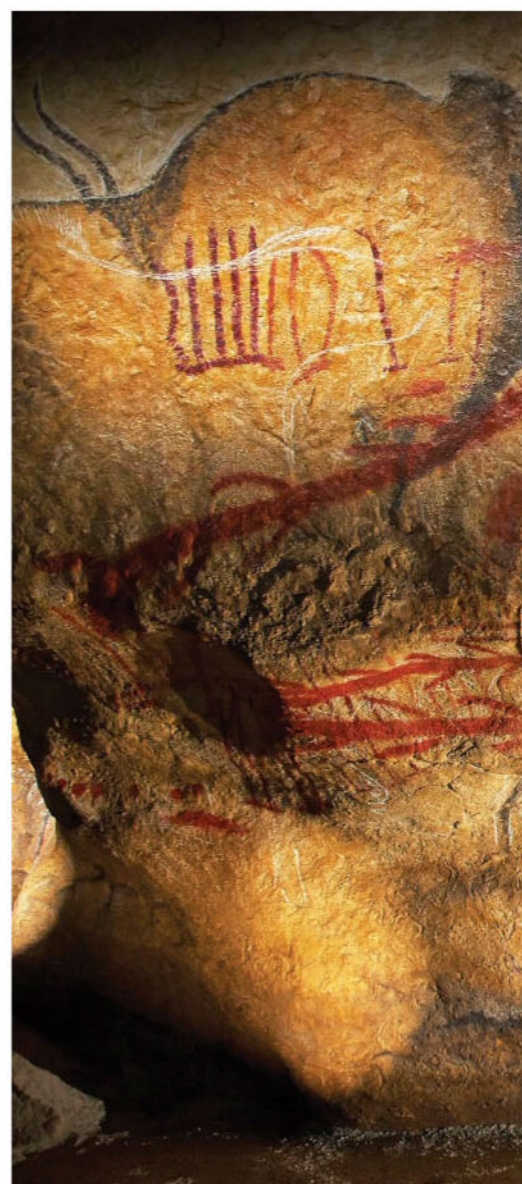
Between 2013 and 2014, von Petzinger visited 52 caves in France, Spain, Italy and Portugal. The symbols she found ranged from dots, lines, triangles, squares and zigzags to more complex forms like ladder shapes, hand stencils, something called a tectiform that looks a bit like a post with a roof, and feather shapes called penniforms. In some places, the signs were part of bigger paintings. Elsewhere,

they were on their own, like the row of bell shapes found in El Castillo in northern Spain (see top picture, page 38), or the panel of 15 penniforms in Santian, also in Spain.

Perhaps the most startling finding was how few signs there were – just 32 in all of Europe. For tens of thousands of years, our ancestors seem to have been curiously consistent with the symbols they used. This, if nothing else, suggests that the markings had some sort of significance. "Of course they mean something," says French prehistorian Jean Clottes. "They didn't do it for fun." The multiple repetitions of the P-shaped claviform sign in France's Niaux cave "can't

Did Stone Age Europeans leave  
coded messages in their caves?  
Alison George finds out

# HIDDEN SYMBOLS





be a coincidence", he argues.

Thanks to von Petzinger's meticulous logging, it's now possible to see trends – new signs appearing in one region, sticking around for a while before falling out of fashion. Hand stencils, for example, were fairly common in the earliest parts of the Upper Palaeolithic era, starting 40,000 years ago, then fall out of fashion 20,000 years later. "You see a cultural change take place," says von Petzinger. The earliest known penniform is from about 28,000 years ago in the Grande Grotte d'Arcy-sur-Cure in northern France, and later appears a little to the west of there before spreading south. Eventually,

it reaches northern Spain and even Portugal. Von Petzinger believes it was first disseminated as people migrated, but its later spread suggests it then followed trade routes.

The research also reveals that modern humans were using two-thirds of these signs when they first settled in Europe, which creates another intriguing possibility. "This does not look like the start-up phase of a brand-new invention," von Petzinger writes in her recently published book, *The First Signs: Unlocking the mysteries of the world's oldest symbols* (Simon and Schuster). In other words, when modern humans first started moving into Europe ➤

"Our ability to represent a concept with an abstract symbol is uniquely human"



BLANCHOT/PHILIPPE/HEMIS/FR/HEMIS/APP



## WHAT DO THEY MEAN?

Geometric marks left alongside murals of animals have attracted the curiosity and scrutiny of archaeologists for decades, although it's only recently that one researcher, Genevieve von Petzinger, has begun systematically cataloguing them all into a searchable database to try to determine their significance (see main story).

For French prehistorian Henri Breuil, who studied cave art in the early 20th century, the paintings and engravings were all about hunting and magic. In the abstract symbols, he saw representations of traps and weapons – meanings that were intrinsically linked to the larger paintings. In the 1960s, the French archaeologist André Leroi-Gourhan declared that lines and hooks were male signs, whereas ovals and triangles were female.

Some of this interpretation has stuck. Circles and inverted triangles are still often cited in the literature as representations of the vulva. It is worth noting that many of the earlier scholars studying cave art were men, which may have led to gender biases in their interpretations. “It’s interesting that it was predominantly male archaeologists doing this work early on, and there were a whole lot of vulvas being identified everywhere. This could have been a product of the times, but then again, many cultures do place importance on fertility,” says von Petzinger.

Later, South African archaeologist David Lewis-Williams proposed a neuropsychological interpretation for some symbols. Like many of his peers, Lewis-Williams believes that at least some Stone Age art was made during or after hallucinogenic trips, perhaps as part of shamanic rituals. If so, the symbols could simply be literal representations of hallucinations. Some studies suggest that drugs and migraines can both provoke linear and spiral patterns, not unlike those seen in ice age art.

But the sad truth is that without a time machine, we may never really know what our ancestors were communicating with these signs.

At El Castillo in Spain, a black penniform and bell-shapes



Black tectiforms at Las Chimeneas, Spain



Etched deer teeth from Saint-Germain-de-la-Rivière, France



COLLECTION MNP LES EYZIES PHOTOS DV PETZINGER

from Africa, they must have brought a mental dictionary of symbols with them.

That fits well with the discovery of a 70,000-year-old block of ochre etched with cross-hatching in Blombos cave in South Africa. And when von Petzinger looked through archaeology papers for mentions or illustrations of symbols in cave art outside Europe, she found that many of her 32 signs were used around the world (see “Consistent doodles”, right). There is even tantalising evidence that an earlier human, *Homo erectus*, deliberately etched a zigzag on a shell on Java some 500,000 years ago. “The ability of humans to produce a system of signs is clearly not something that starts 40,000 years ago. This capacity goes back at least 100,000 years,” says Francesco d’Errico from the University of Bordeaux, France.

## The writing’s on the wall

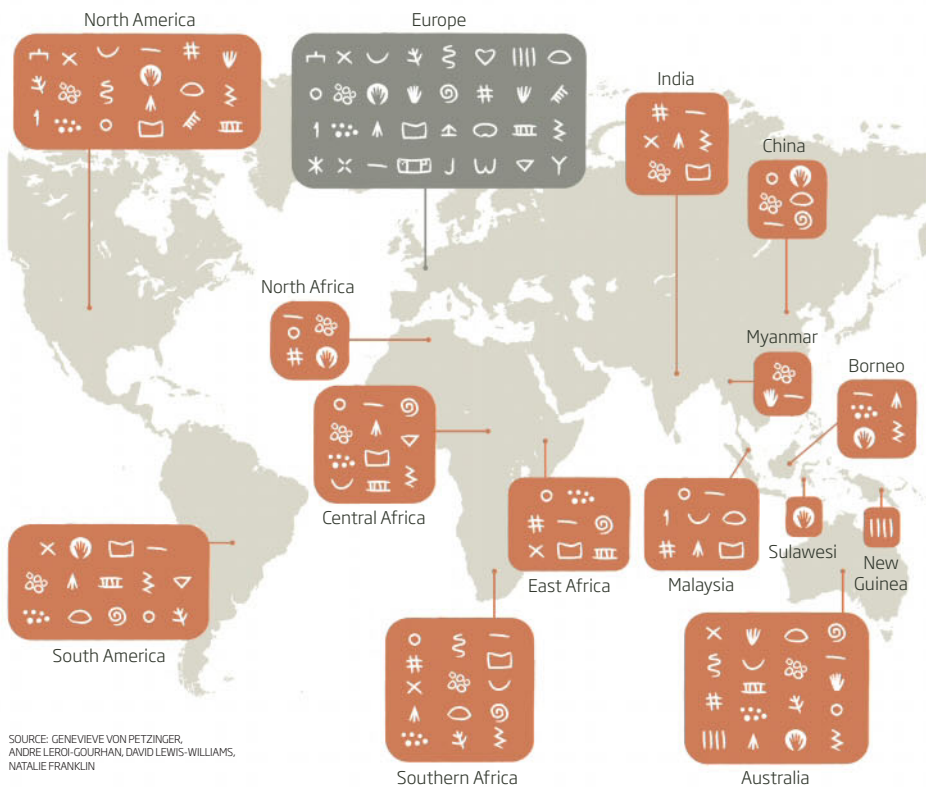
Nonetheless, something quite special seems to have happened in ice age Europe. In various caves, von Petzinger frequently found certain symbols used together. For instance, starting 40,000 years ago, hand stencils are often found alongside dots. Later, between 28,000 and 22,000 years ago, they are joined by thumb stencils and finger fluting – parallel lines created by dragging fingers through soft cave deposits.

These kinds of combinations are particularly interesting if you’re looking for the deep origins of writing systems. Nowadays, we effortlessly combine letters to make words and words to make sentences, but this is a sophisticated skill. Von Petzinger wonders whether the people of the Upper Palaeolithic started experimenting with more complex



## Consistent doodles

The symbols seen on relics from Stone Age Europe are also found in caves throughout the rest of the world. The similarities suggest the marks are more than just random scribbles



SOURCE: GENEVIEVE VON PETZINGER, ANDRÉ LEROI-GOURHAN, DAVID LEWIS-WILLIAMS, NATALIE FRANKLIN

ways of encoding information using deliberate, repeated sequences of symbols. Unfortunately, that's hard to say from signs painted on cave walls, where arrangements could be deliberate or completely random. "Demonstrating that a sign was conceived as a combination of two or more different signs is difficult," says d'Errico.

It was while she was grappling with this conundrum that von Petzinger found out about the necklace of red deer teeth. It was found among other artefacts in the grave of a young woman who died some 16,000 years ago in Saint-Germain-de-la-Rivière, in south-west France. From a description in a book, von Petzinger knew that many of the teeth had geometric designs carved into them. So she travelled from Canada to the National Museum of Prehistory in Les Eyzies-de-Tayac, where the teeth were held, in the hope that they might be a missing piece of her puzzle.

The moment she flipped the first one, she knew the trip had been worthwhile. The X and straight lines were symbols she had seen together and separately on various

## DIVING FOR ART

Some of the most stunning cave art in Europe was only discovered in 1985, when divers found the mouth of the Cosquer cave 37 metres below the Mediterranean coastline near Marseilles in southern France. Its entrance had been submerged as sea levels rose after the last ice age. Chances are, other similar caves are waiting to be discovered.

So von Petzinger has teamed up with David Lang of OpenROV in Berkeley, California, which makes low-cost, underwater robots. Next year, they plan to use them to hunt for submerged cave entrances off Spain's north coast. The region is rich in painted caves, many close to the shoreline, so it seems likely that others could be hiding below the waves.

If they find any, the pair will send in the remote-controlled mini-submarines, armed with cameras, to safely explore the new sites.

cave walls. Now here they were, with the X sandwiched between two lines to form a compound character (see photo, bottom left). As she turned each tooth over, more and more decorations were revealed. In the end, 48 were etched with single signs or combinations, many of which were also found in caves. Whether or not the symbols are actually writing depends on what you mean by "writing", says d'Errico. Strictly speaking, a full system must encode all of human speech, ruling the Stone Age signs out. But if you take it to mean a system to encode and transmit information, then it's possible to see the symbols as early steps in the development of writing. That said, cracking the prehistoric code (see "What do they mean?", left) may prove impossible. "Something we call a square, to an Australian Aborigine, might represent a well," says Clottes.

For d'Errico, we will never understand the meaning of the symbols without also considering the animal depictions they are so often associated with. "It is clear that the two make sense together," he says. Similarly, cuneiform is composed of pictograms and counting tallies. A ration, for instance, is represented by a bowl and human head, followed by lines to denote quantity.

Von Petzinger points out another reason to believe the symbols are special. "The ability to realistically draw a horse or mammoth is totally impressive," she says. "But anybody can draw a square, right? To draw these signs you are not relying on people who are artistically gifted." In a sense, the humble nature of such shapes makes them more universally accessible – an important feature for an effective communication system. "There's a broader possibility for what they could be used for, and who was using them."

More than anything, she believes the invention of the first code represents a complete shift in how our ancestors shared information. For the first time, they no longer had to be in the same place at the same time to communicate with each other, and information could survive its owners.

The quest is far from over. Von Petzinger plans to expand her Stone Age dictionary by adding in the wealth of signs on portable objects, in caves on other continents and maybe even those found beneath the waves (see "Diving for art", left). "We only have part of the picture now. We are on the cusp of an exciting time." ■

Alison George is an editor at *New Scientist*

# Danger and drama on mountains of lava

Volcanoes are hotspots for spirituality and cultural identity, says globetrotting volcanologist Clive Oppenheimer, and science ignores this human side at our peril

**Your most famous escapade as a volcanologist was a trip to North Korea. How did that happen?**

I went because they asked me. The government was concerned that recent earthquakes might signal a repeat of one of the most dramatic volcanic eruptions of the past 2000 years, which occurred at Mount Paektu, on the present-day border with China. They wanted some outside expertise. Before going there for the first time in 2011, I knew something of the geological history, but I had no idea that the volcano is also a national icon. Koreans, across the peninsula, have long believed that they are descended from people who came from Mount Paektu. And Kim Il-Sung, the founder of modern North Korea, rekindled this ancient myth. The secret camps he established while fighting against Japanese occupation in the 1940s are on the flanks of the volcano. It is claimed that his son and successor, Kim Jong-Il, was born there.

Today the volcano is a pilgrimage site. Students, soldiers and newly-weds visit. Kindergarten children sing *Let's go to Mount Paektu*. I went back to the volcano for the filming of a new documentary directed by Werner Herzog, *Into the Inferno*.

**Do you enjoy this mythologising of volcanoes?**

Yes. Volcanologists take oral traditions seriously. Myths and legends often tell us important things. When Mount Pinatubo blew in the Philippines in 1991 – the largest eruption in over a century – volcanologists were caught by surprise. It wasn't recognised as a volcano that might come back to life. It later turned out that there was a local folk story, recorded by outsiders in 1915, describing a big eruption that probably occurred centuries ago. If this had come to light before

the event, it might have alerted scientists to the volcano's threat. We need to listen to such stories. We now have powerful technologies for monitoring volcanoes, but we need to deploy them in the right place to pick up warning signs in time.

**But surely myths are usually just myths.**

I don't know how many of them have some basis in experience and fact, but what is striking is how important oral traditions are in helping people make sense of vast and unpredictable events in their lives. I respect that.

For the documentary, we filmed people on Tanna, a Pacific island in Vanuatu, who belong to a "cargo cult" based around a mythical American GI called John Frum. Some say he lives in their volcano, the constantly erupting Mount Yasur [pictured], and uses it as a portal to the US. One day, he will return through the volcano bringing riches, says the local chief. The cult seems to have started as part of a movement against the French and British colonial authorities. American GIs arriving from the air during the second world war were seen as liberators. The result is an extraordinary fusion of the awe-inspiring power of the volcano, a movement rooted in anti-colonialism, the rediscovery of suppressed traditions and the marvel of American troops and warplanes.

**What do traditional societies make of volcanologists?**

They can be suspicious. And why not? On the slopes of Mount Merapi, a very active and dangerous volcano on the densely populated Indonesian island of Java, there is a traditional spiritual guardian appointed by the sultan of the nearby city of Yogyakarta to speak with the

## PROFILE

Clive Oppenheimer is a volcanologist at the University of Cambridge. He is author of *Eruptions that Shook the World* (2011) and features in *Into the Inferno*, a documentary directed by Werner Herzog, now on Netflix

**Mount Yasur on the Pacific island of Tanna erupts continuously**

volcano on behalf of the people. In 2006, when Merapi began to erupt, the guardian at that time, Mbah Maridjan, defied a government evacuation order and stayed in his village. When he survived, apparently proving the experts wrong and the spirits right, he became a celebrity.

Then, in 2010, Merapi erupted again. The guardian once more refused to leave his village. But it was the biggest eruption for over a century and he was among the 350 who died, engulfed by a very hot flow of rocks, ash and gas that hurtled down the mountain. Two years later, tourists were coming to see where he died and his widow was running a gift shop selling T-shirts with her husband's image on them.

Scientists were better regarded after that, though. There was even a campaign to make the chief volcanologist – who oversaw the monitoring and mass evacuations in 2010 – the new spiritual guardian. It didn't happen, but







PETER ZEITLINGER/NETFLIX

when we were filming at a festival on Merapi, that volcanologist was invited to a ceremony at which the elders blessed offerings to the volcano. It was a fascinating reconciliation between the spiritual and scientific worlds.

#### **What have you been doing as a geologist amid this anthropology?**

On Merapi, I have been involved in a project to set up equipment to monitor sulphur fumes coming out of the volcano, which can indicate magma movement deep underground. The Indonesian scientists also monitor changes in the shape of the cone and the earthquakes beneath the volcano. Put together, this work helped save many thousands of lives by

getting people out of harm's way in 2010. My main research looks at the gases given off by volcanoes, to find out what they can tell us about the processes going on many kilometres beneath our feet and help us forecast eruptions. We now have devices such as infrared spectrometers that can provide fabulously detailed observations of the chemical composition of the gases. We see amazing trends in the emissions of gases such as carbon dioxide and sulphur dioxide over time. The challenge in my work is to interpret what these shifts and patterns might be telling us, and whether or not they provide clues to the future activity of a volcano.

#### **What got you hooked on volcanoes?**

I went to Indonesia in 1983, partly to see a solar eclipse, but I also went island-hopping to climb volcanoes. One had erupted just the night before. It was amazing to see a forest

destroyed and to leave my footprints in the new ash. I was captivated and ended up in Sumatra on an island in the giant crater lake created when Mount Toba erupted there 74,000 years ago. It was a gigantic eruption, about ten thousand times bigger than the Mount St Helens eruption in 1980. It has been suggested that it shrouded the planet in dust, creating a volcanic winter.

Some researchers believe Toba almost wiped out our species. It is a controversial idea, and we may never know Toba's true impact, but it's possible that a future eruption of a Toba-like supervolcano represents an existential threat to humanity. Such a catastrophe could be lurking in some place we don't even know about right now. Unless, of course, some oral tradition in a remote village could warn us. ■

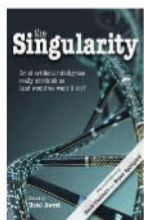
Interview by Fred Pearce

**"An American GI called John Frum uses the volcano as a portal to the US"**

# A singular proposition

Creating AI may be inevitable - unless we're already part of a simulation dreamed up by a hyper-intelligent entity, says **Bruce Sterling**

*The Singularity: Could artificial intelligence really out-think us (and would we want it to)?* edited by Uziel Awret, Imprint Academic, £29.95



THIS is certainly the best book about the singularity. It features 26 intelligent scholars from 11 widely varying disciplines, all of them valiantly grappling with ghosts.

Given that the subject matter is so highly speculative, so lofty, so indefinable, this tome is heavy going. Among its talents are nine philosophers and nine artificial intelligence researchers. These worthies mercilessly lay it on with their specialised jargon. It takes a sturdy, dedicated reader to plough those thickets of prose.

Worse yet, since *The Singularity* is a work of metaphysical philosophy, you know from the start that no amount of argument will settle its complex issues.

The book opens with a target essay by philosopher of mind David Chalmers. Each contributor fires at Chalmers with their heavy intellectual artillery, and he then appears at the close of the book to briskly refute their objections with his premises unscathed.

While the book is a tremendous flight over the craggy AI landscape, it settles no disputes and has little or nothing in the way of practical counsel.

Kant, Hume and Descartes are major intellectual presences here, apparently because explosively proliferating future AI singularities are going to be plenty worried about these three dead European guys.

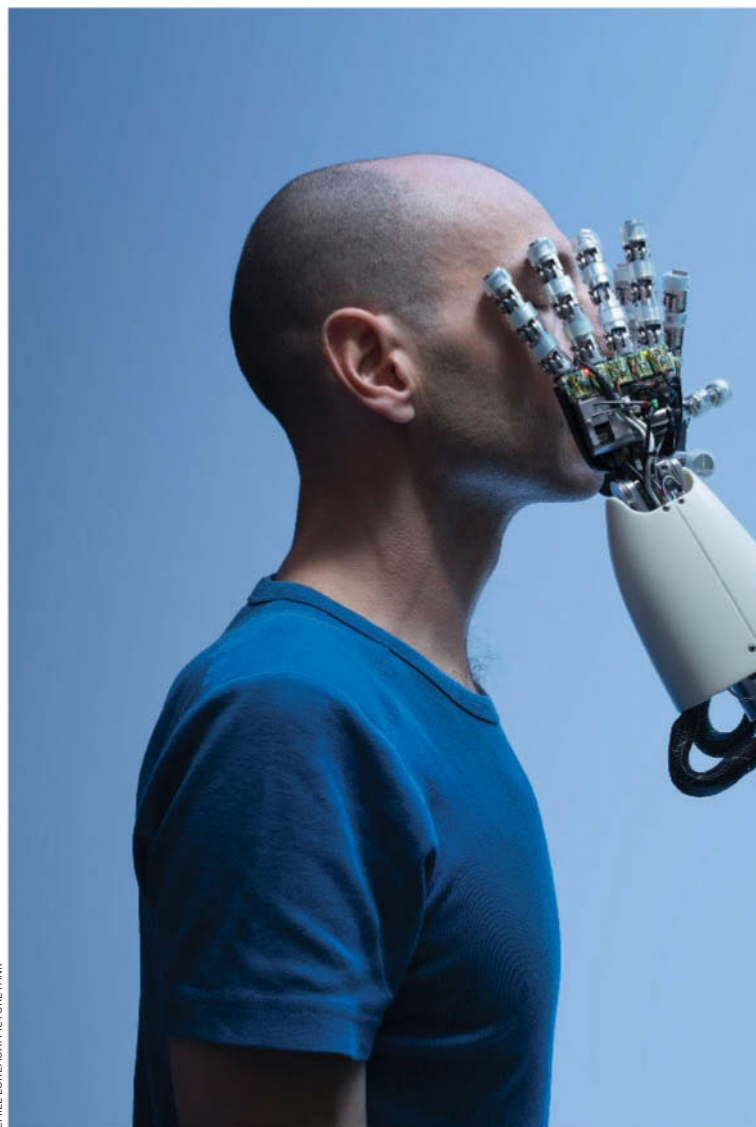
The tone of the book is mostly grave, sombre, even pre-apocalyptic (except for Daniel Dennett, who can't resist making sarcastic fun of a younger colleague, and Damien Broderick, who clearly enjoys explaining science fiction writers to philosophers).

*The Singularity* comports itself as if confronting a serious public emergency. But is it serious?

Maybe. The book is the one the president of the US would need if we lived in a techno-thriller where Siri tried to seize power. Imagine an emergency NATO summit where terrified global diplomats needed expert briefings from metaphysicians. The contributors of this book would definitely be those guys.

Here's the central issue with a singularity – as Chalmers frames it. We certainly know that intelligence exists (because we've got some). Being intelligent, we've probably got enough technical smarts to create some contraption that is, in at least some ways, as intelligent as us – meaning AI.

**"The US president would need this book if we lived in a techno-thriller where Siri tried to seize power"**



EMILE LOREAU/PICTURETANK

Humans equipped with AI would then have the capacity to invent what Chalmers calls AI+. This new entity would then deploy its active, ambitious ability to build still further entities, dubbed AI++, and pretty much outside our human ken entirely. That would be, well, problematic.

It boils down to a technical question of the ratio of AI's capacity to compute versus its capacity to construct. If a little bit of extra smarts makes AI an ace hardware engineer, then we're really sunk.

On the other hand, if AI+ is truly brilliant but wants to spend

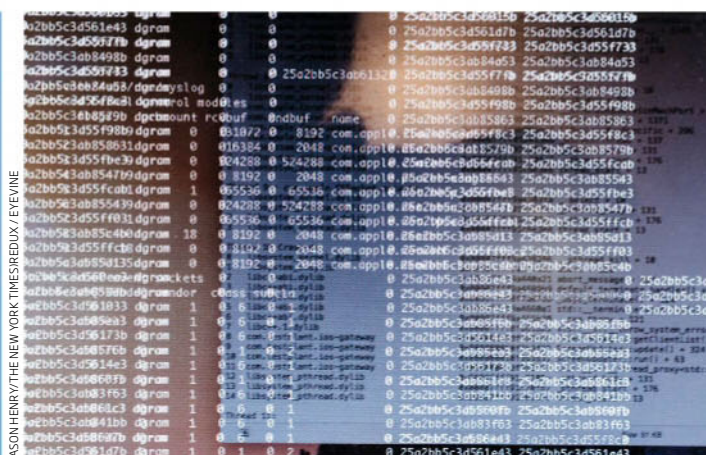
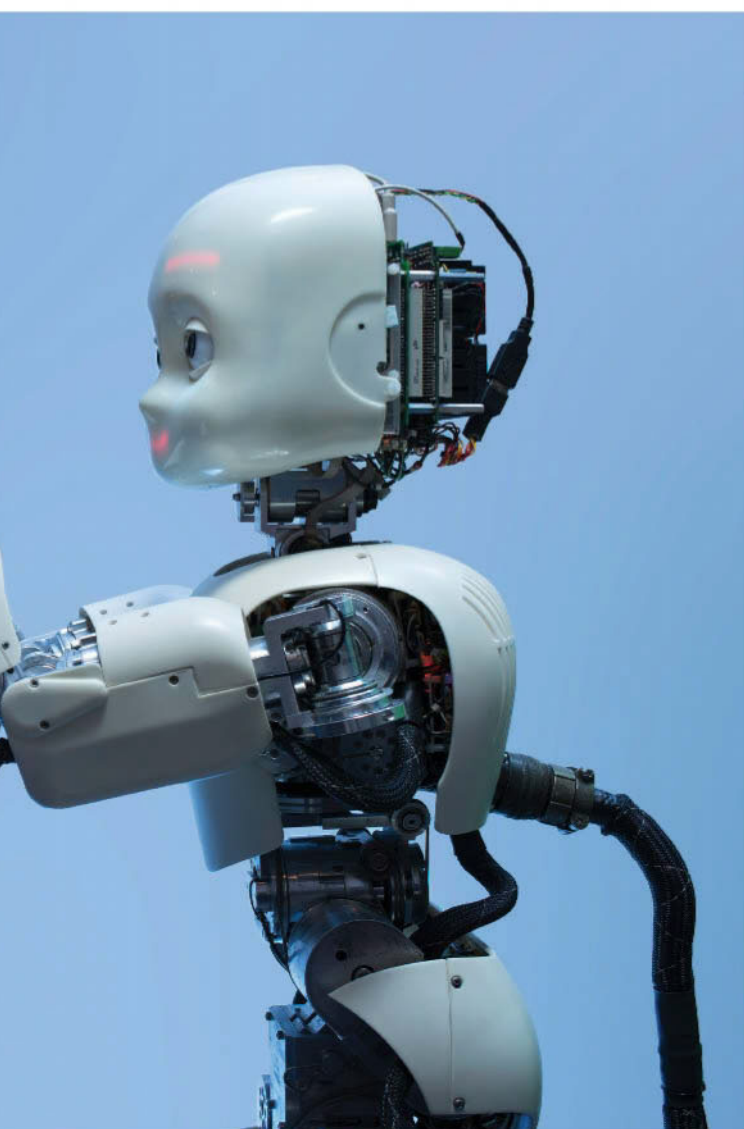
its energies pondering Kantian ethics, then we've lucked out, and the singularity becomes a more remote threat. However, the singularity will still happen.

Chalmers is sincerely convinced that a singularity is our destiny. Although progress in AI has been fitful to date, he believes that these developmental stages logically imply one another. So sooner or later, humankind will invent a true Artificial Intelligence: a thinking machine that fully deserves attributes such as wisdom, acumen, self-awareness, mind and consciousness.



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Once an AI+ acquires those nebulous mental qualities, it will no longer be some merely standard chatbot, deep-learning neural network, genetic algorithm, theorem prover, expert system, fuzzy logician and/or evolved program.

No, that AI+ would be a genuine peer-competitor of humankind, a conscious and numinous being necessarily featuring goals, desires, preferences and values.

The AI+, though, is made of code and software. So it could probably expand its capacities with standard cyber-industrial procedures. So, even if AI++ is not

a sudden, destructive “singularity bomb”, even if the construction of AI++ by the AI+ takes decades or centuries, humans will still, eventually, be among intelligent entities that can out-think us as we out-think mice.

This truly major philosophical issue does not hugely upset Chalmers since, as a metaphysician, he suspects that consciousness is a primal aspect of our universe. This implies that the AI++ mind isn’t entirely alien to our own being, but is an amplification, a mind with our essential mental qualities, though bigger and faster and

**I think, too: a conscious AI is not some evolved program but a genuine competitor of humankind**

made of different materials.

This means that we could enjoy the standard singularity hobby of uploading and downloading our brains on to other substrates. The implications are many. We might perhaps be signing long-term contracts with the postbiological creatures of roboticist Hans Moravec’s book *Mind Children* so that they have an incentive to look after us, rather than simply squashing us like bugs.

It’s a new, post-singular, strange order of being, yes, but even a mouse survives in a world whose superior intelligence tolerates and even understands it.

So we’re mice-to-be, and that’s politically challenging... unless, that is, we’ve already been simulated by some hyper-intelligent A++ entity. It may be that we merely perceive ourselves as human beings. Maybe, in a higher reality, we are all the software constructs of a godlike cyber-entity that runs our code out of some vague sense of obligation.

This is where Monsieur Descartes pops up suddenly, and being René Descartes, he gets an extended cogito-ergo-sum look-in on the hot topic of us not really being here at all.

Being a science-fiction writer and a veteran reader of Philip K. Dick, I’m inclined to indulge

this philosophical conundrum. I enjoyed it. It’s entertaining. However, compared with the stark moral urgency of humanity being torn up for computronium scrap by malware AIs, I frankly have to wonder why our non-existence is even mentioned. Because, if we humans don’t exist, that is pretty awesome, but it’s mighty awkward. Really, it’s a faux pas.

**“Maybe, in a higher reality, we are all the software constructs of a godlike cyber-entity”**

A serious worrier might protest that even if we’re already victims of a singularity, and we always have been we could still have another one here in our little pocket sandbox of a singularity. But isn’t that over-egging the pudding? Where’s the moral urgency in our being 10,000 AI angels on a pin?

The current US president, to judge by his recent public statements, is sincerely worried about sudden, lurching, dangerous advances in computation. But if the president doesn’t exist at all (and the apparent odds seem to favour that cosmic possibility) wouldn’t he just clap this heavy book shut, and throw the silly thing across the room? ■

Bruce Sterling is a writer and critic who divides his time between the US, Italy and Serbia



# Speaking in tongues

A Tom Wolfe take on language is a mixed blessing, finds **Alun Anderson**

*The Kingdom of Speech* by Tom Wolfe, Jonathan Cape, £14.99



TOM WOLFE, one of America's best-known writers, has been skewering the pompous and the self-obsessed for five decades. In his bestseller *The Bonfire of the Vanities*, he took on greed and ambition among New York bond traders.

His latest book is *The Kingdom of Speech*. On the surface, it is about the struggle to understand the origin of language, but you soon discover that it is also a tale of two heroic outsiders who come up against the dead weight of the academic establishment. This is familiar Wolfe territory and you know which side he is on.

His starting point is a paper by US linguist Noam Chomsky and his colleagues from 2014, which seems to confess that decades of research into language have led nowhere. Wolfe appears shocked, saying they were “throwing in the towel... crapping out when it came to the question of where speech – language – comes from and how it works”. The style is instantly recognisable, and the book hurtles on for 160 pages of wicked, opinionated, high-velocity prose.

Wolfe's first protagonist is naturalist Alfred Russel Wallace, who clashes with Charles Darwin over whether their theory of evolution can account for language. Then there's US linguist Daniel Everett, whose important dispute with Chomsky and his school of language runs today.

Both Wolfe's heroes are adventurers. Wallace struggles with fever after fever on his travels, and has to bury a companion. During Everett's many years with the Amazonian Pirahã tribe, learning their extraordinary language, his wife and daughter nearly die.

Both men are also tremendous writers. Everett's *Don't Sleep, There are Snakes* is an international bestseller. But they are outsiders. Wallace is not a “gentleman” but must collect specimens from far-off lands to survive. Everett, a fieldworker, is apparently scorned by “air-conditioned armchair linguists with their radiation-bluish computer-screen pallors and faux-manly open shirts”.

Darwin is long dead and will not

be offended by Wolfe's treatment of him as an anguished hypochondriac. Chomsky and his disciples may be less pleased.

Back in the 1950s, a brilliant young Chomsky is seen punching big holes through B. F. Skinner's behaviourist psychology, arguing that children pick up language so

**“Enter Everett, with a paper delivering an ‘OOOF! – right into the solar plexus!’ of the Chomsky tribe”**

easily the underlying rules must be stored in their brains. Language is an instinct, Chomsky claims, and with his rise to fame as one of the world's greatest intellectuals, the hunt for its “universal grammar” dominates linguistics.

Enter Everett in 2005, with a

paper delivering an “OOOF! – right into the solar plexus!” of the Chomsky tribe. His claim: the Pirahã language does not fit universal grammar but their unique culture. Language is not an instinct, but a cultural invention shaped by evolution.

The challenge is big and the response ugly. Everett is labelled an “out-and-out liar”, and Chomsky calls him “a charlatan”. But Everett's bestseller turns him into a folk hero “standing up to daunting Dictator Chomsky”.

That is the essence of Wolfe's fable and it is a riveting read. But be warned: it is partisan, Wolfe's grip on the science is sometimes insecure and his story has no real end. Everett's work has not convinced researchers, as Wolfe might wish, that they have wasted 50 years on “Chomsky's doctrine of Universal Grammar”. That said, many will agree Everett is right to think that language needs much more than the study of grammar.

We need to know how humans evolved cooperative cultures with communication at a premium and the role of theory of mind that lets us understand the intentions of others. Then there's the appearance of symbolic thought and how language comes to “mean” something. Not to mention how language may have co-evolved with culture to slowly acquire grammatical complexity.

All these and more are active research areas. Everett himself has two books out soon. After more storms pass, I'd bet we'll see a grand new synthesis that may cast quarrelsome academics in a better light than Wolfe allows. ■

Alun Anderson is a consultant for *New Scientist*



Tom Wolfe, taking on the academic establishment over language

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**Contact Information:** Helen Schwickrath, Search Administrator, Department of Chemistry and Chemical Biology, Harvard University, 12 Oxford St., Cambridge, MA 02138, Phone: 617-496-8190 Email: [helen@chemistry.harvard.edu](mailto:helen@chemistry.harvard.edu)

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# The 2017 Louisa Gross Horwitz Prize for Biology or Biochemistry

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**Deadline date: January 25, 2017**

Renominations are by invitation only.  
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The Louisa Gross Horwitz Prize was established under the will of the late S. Gross Horwitz through a bequest to Columbia University and is named to honor the donor's mother. Louisa Gross Horwitz was the daughter of Dr. Samuel David Gross (1805-1889), a prominent surgeon of Philadelphia and author of the outstanding *Systems of Surgery* who served as President of the American Medical Association.

Each year since its inception in 1967, the Louisa Gross Horwitz Prize has been awarded by Columbia University for outstanding basic research in the fields of biology or biochemistry. The purpose of this award is to honor a scientific investigator or group of investigators whose contributions to knowledge in either of these fields are deemed worthy of special recognition.

The Prize consists of an honorarium and a citation which are awarded at a special presentation event. Unless otherwise recommended by the Prize Committee, the Prize is awarded annually. Dr. Howard Cedar, University of Jerusalem, Jerusalem, Israel, Dr. Gary Felsenfeld, NIH Distinguished Investigator, Baltimore, MD, and Dr. Aharon Razin, University of Jerusalem, Jerusalem, Israel were the 2016 awardees.

## Qualifications for the award

The Prize Committee recognizes no geographical limitations. The Prize may be awarded to an individual or a group. When the Prize is awarded to a group, the honorarium will be divided among the recipients, but each member will receive a citation. Preference will be given to work done in the recent past.

## Nominations should include:

- 1) A summary of the research on which this nomination is based (no more than 500 words).
- 2) A summary of the significance of this research in the fields of biology or biochemistry (no more than 500 words).
- 3) A brief biographical sketch of the nominee, including positions held and awards received by the nominee.
- 4) A key publication list of up to ten of the nominee's most significant publications relating to the research noted under item 1.
- 5) A copy of the nominee's curriculum vitae.

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**Departments** - Awards related to the following areas are anticipated: Applied Ocean Physics & Engineering; Biology; Geology & Geophysics; Marine Chemistry & Geochemistry; Physical Oceanography; and in cooperation with the USGS laboratory located on the WHOI campus.

**Institutes** - Each Institute fosters interdisciplinary research addressing critical issues, and we will award a scholarship to support related research: Ocean and Climate Change Institute; Coastal Ocean Institute; Ocean Exploration Institute; Ocean Life Institute

**The National Ocean Sciences Accelerator Mass Spectrometry Facility (NOSAMS)** will award a fellowship in the development and implementation of new techniques in marine science radiocarbon studies.

**A joint USGS/WHOI award** will be given to a postdoc whose research is in an area of common interest between USGS and WHOI Scientific Staff. The individual will interact with both USGS and WHOI based advisors on their research.

Awards are competitive, with primary emphasis placed on research promise. Scholarships are 18-months with an annual stipend of \$58,500, a research budget and eligibility for health and dental insurance. Recipients are encouraged to pursue their own research interest in association with resident staff. Communication with potential WHOI advisors prior to submitting an application is encouraged.

Further information may be obtained at:

[www.whoi.edu/postdoctoral](http://www.whoi.edu/postdoctoral)

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## Postdoctoral Opportunity

The National Institute on Aging (NIA), a major research component of the National Institutes of Health (NIH) and the Department of Health and Human Services (DHHS), is recruiting for a postdoctoral position within The Laboratory of Molecular Gerontology. The Bohr Laboratory works on mitochondrial DNA damage, repair and bioenergetics, neuronal DNA damage and repair, Alzheimer's disease related research and the role that human RecQ helicases play in genome maintenance. We are looking for a highly motivated candidate with proven expertise in *C. elegans* use, molecular biology, protein biochemistry and cell biology and good oral and written communication skills. Individuals with knowledge of metabolomics, mouse or worm genetics are strongly encouraged to apply.

Interested candidates must have a Ph.D. or M.D. with less than five years of relevant postdoctoral experience. Salary is commensurate with experience and accomplishments.

To apply submit letter of interest, curriculum vitae, and references to: **Vilhelm A. Bohr**, Ph.D., Chief, LMG, NIH/NIA/IRP, Laboratory of Molecular Gerontology, Biomedical Research Center, 251 Bayview Blvd, Baltimore, MD 21224 USA.

Phone: **410-558-8162** or e-mail: [bohrr@mail.nih.gov](mailto:bohrr@mail.nih.gov)

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<http://www.grc.nia.nih.gov/branches/lmg/vbohr.htm>





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## KANSAS STATE UNIVERSITY

### ASSISTANT PROFESSOR IN THEORETICAL ULTRAFAST AMO PHYSICS DEPARTMENT OF PHYSICS KANSAS STATE UNIVERSITY

The Department of Physics at Kansas State University seeks candidates for a tenure-track assistant-professor position in theoretical atomic, molecular, and optical physics, with research focus on light-induced ultrafast dynamical processes in matter. The successful candidate is expected to build and sustain a vigorous, internationally recognized research program that overlaps with and complements ongoing research in the department's large AMO group. The department has outstanding experimental and theoretical AMO physics programs that are directed by 11 faculty members and address an array of forefront problems in AMO science. A significant part of the department's AMO physics research is conducted in the J. R. Macdonald Laboratory (JRML), primarily with funding from the U. S. Department of Energy. Research conducted at JRML includes investigations of the light-driven dynamics in atoms, molecules, and complex systems by employing state-of-the-art ultrafast intense laser and detection techniques, as well as nonlinear optics and optical source development. For a description of current research at JRML see <http://jrm.phys.ksu.edu/>.

The successful candidate must present credentials that justify an appointment at the assistant-professor level, including a Ph.D. (or equivalent degree) in AMO physics or a related discipline, and should demonstrate a strong commitment to teaching and mentoring students at all levels and to serving a diverse population. Applications, including a cover letter, CV, and statements of research and teaching interests along with a list of references should be submitted to: <http://careers.k-state.edu/cw/en-us/job/497698/assistant-professor-in-theoretical-ultrafast-amo-physics>.

Screening of applicants will start immediately and continue until the position is filled. Background checks are required. Kansas State University is an affirmative action equal opportunity employer and actively seeks diversity among its employees.



UNC CHARLOTTE

### Faculty Position Computational Genomics

Department of Bioinformatics and Genomics  
College of Computing and Informatics  
University of North Carolina at Charlotte

The Department of Bioinformatics and Genomics at the University of North Carolina at Charlotte seeks a tenure-track professor at any career stage to work at our location in the North Carolina Research Campus (NCRC) in Kannapolis. The NCRC is a public-private partnership between corporations, universities and healthcare organizations advancing science at the intersection of human health, nutrition and agriculture.

The NCRC hosts, UNC Charlotte, six other UNC system universities as well as Duke University. UNC Charlotte has a leadership position at the NCRC in bioinformatics. We seek applicants wishing to develop a research program in bioinformatics, computational biology and/or computational genomics. This position is part of a larger university-wide research initiative in Data Science and Analytics. The successful applicant will have an earned doctorate with an exceptional record of achievement and will be expected to maintain an externally funded research program that will catalyze a larger group of interdisciplinary scientists. The responsibilities of the position include teaching quantitative skills such as programming and statistical modeling at the graduate and undergraduate level.

We offer a collegial environment, excellent facilities, a competitive start up package, and a competitive nine-month salary commensurate with experience.

Preliminary inquiries about the position can be made to Dan Janies via email [djanies@uncc.edu](mailto:djanies@uncc.edu). However, formal applications must be made electronically at <https://jobs.uncc.edu> (position #1074) and must include a CV, contact information for 4 references, and statements on research and teaching. The University of North Carolina at Charlotte is an EOE/AA employer and an NSF ADVANCE institution.

For additional information, please visit our websites at <http://bioinformatics.uncc.edu> and <http://transforming-science.com>.





## Full Time Research Associate Software Development

UNC Charlotte Department of Bioinformatics is seeking a full time Software Developer. The incumbent will lead the development of bioinformatics web servers, resources and applications. He/she will also work on big data integration and analysis. One focus is the Pathview project. Pathview is an open-source package that maps, integrates and renders a large variety of biological data onto pathways, and produces interpretable graphs with publication quality. Pathview was quickly adopted and widely used by thousands of scientists worldwide. With a major NSF grant recently awarded, Pathview will be fully developed as a systematic solution for pathway based analytics and visualization.

For more information about the research in our group:

<http://pathview.uncc.edu/>

<http://bioconductor.org/packages/pathview/>

<http://bioconductor.org/packages/gage/>

### Technical skills:

- LAMP based web + database development (PHP & JavaScript & MySQL preferred)
- Unix/Linux shell
- Python or Java
- Version control: svn and git
- Data integration and visualization
- R/Bioconductor is a plus, understanding molecular biology is a plus

### Other qualifications:

- Excellent communication and problem-solving skills, attention to detail
- Ability to work independently and in a team
- Self-motivated and disciplined, time and project management skills
- Enjoy building highly quality software, enjoy data analysis
- Proven development experience, publication record is a plus

**Education:** Bachelor or advanced degree + 3 years working experience in bioinformatics, computer science or related fields.

**Salary & benefits for the Research Associate Position:** Competitive package

**Start Date:** As soon as possible

**Application/inquiry:** Preliminary inquiries about the position can be made to Weijun Luo via email [weijun.luo@uncc.edu](mailto:weijun.luo@uncc.edu). Please include a short cover letter, CV and the names of 2-3 references. Applicant can submit a formal application electronically at <https://jobs.uncc.edu> EHRA Staff (position 1047).



## Full Time Research Associate Biostatistics/Bioinformatics

UNC Charlotte Department of Bioinformatics is seeking to hire a full time Biostatistics/Bioinformatics Scientist. The incumbent will develop statistical/computational methods/tools for high throughput omics (genome, transcriptome, proteome, metabolome etc) data integration, analysis and visualization; apply them to complex diseases/traits and biomedical problems. He/she will participate in the Pathview project. Pathview is an open-source package widely used for based pathway based analytics and visualization.

For more information about the research in our group:

<http://biorniv.org/content/early/2016/05/11/052878>

<http://bioconductor.org/packages/pathview/>

<http://bioconductor.org/packages/gage/>

<http://pathview.uncc.edu/>

### Technical skills:

- Solid statistics training
- Genetics/genomics data analysis (esp. GWAS, Whole Genome/ Exome Studies), NGS data analysis, sequence analysis
- R/Bioconductor
- Unix/Linux shell
- Python or Perl
- Version control: svn and git
- R package (or software) development is a plus

### Other qualifications:

- Excellent communication and problem-solving skills, attention to detail
- Ability to work independently and in a team
- Self-motivated and disciplined, time and project management skills
- Enjoy computational/statistical method development, data analysis
- Proven research/development experience, publication records

**Education:** PhD (or Master + 3 years working experience) in statistics/biostatistics, bioinformatics, computational genetics, computer science, or related fields.

**Salary & benefits for the Research Associate Position:** Competitive package

**Start Date:** As soon as possible

**Application/inquiry:** Preliminary inquiries about the position can be made to Weijun Luo via email [weijun.luo@uncc.edu](mailto:weijun.luo@uncc.edu). Please include a short cover letter, CV and the names of 2-3 references. Applicant can submit a formal application electronically at <https://jobs.uncc.edu> EHRA Staff (position 1047).



## Clinical Scientist Liaison (CSL)

### SUMMARY

The Clinical Scientist Liaison (CSL) is part of the Medical Services Team and as such, provides support to Sales, Product Development, Research, and Client Services for Molecular Health, a leading precision medicine technology company. The role includes using their scientific and/or clinical expertise to generate genetic/genomic content for the expanding clinical knowledge database, assistance with developing and testing MH products, provide customer support in the use of MH products, and assist in Pre-Sales support. Reporting to the Executive Director, Medical Affairs. The Medical Services Team has roles in support for many company functions, including: Software Development, Sales, Marketing, Business Development, Operations, Research, Innovation, and Finance. The CSL may be called on to perform additional tasks to support these groups.

### PRIMARY RESPONSIBILITIES

In collaboration with other members of the Medical Services Team, as well as the scientific content team (part of Research) help generate clinical genomic content for MH products. Specifically, this will include:

- Review the current literature to attain mastery of cancer biology, cancer therapies, targetable pathways, and precision medicine
- Apply knowledge of the above in the generation of Clinical Variant Interpretations, a key component of the MH offerings
- Support users of MH products, to this end will need to gain experience in the medical workflow of molecular diagnostic laboratories
- Support development of MH products, by performing testing functions and clinical validations
- Support Sales in demonstrating MH products to customers, either remotely or on location
- Add support for research & clinical studies, as well as for generating scientific publications
- Assist with clinical sign-out activities (only while the molecular diagnostics lab is operational, estimated end date Dec 31st, 2016)

### Other responsibilities:

- May be required to assist with managerial roles such as assigning duties, hiring new talent, training employees and evaluating their performance.
- Help to educate the sales team as to the where the product value proposition provides key business solutions for customers, partners, and prospects.
- Understand and articulate the product's USPs.
- Support Marketing & Product Development to build marketing, education, and training materials/programs that support marketed products & products in development.
- Support and strengthen the overall business by driving innovative ideas, solutions and products.
- Interact closely (as necessary) with Software Development, Project Management, the Medical Services Team, and Research/Innovation.

### ACCOUNTABILITIES

- Develop & ensure the quality of genomic analysis narratives for Guide
- Perform testing and validation functions for products
- Interact with MH customers and prospects, supporting Sales and Client Services
- Contribute to product design/development for Guide
- Help to define new product requirements
- Provide genomic training for internal staff and clients

### KNOWLEDGE AND SKILL REQUIREMENTS

- PhD or MD with expertise in Cancer Biology/Molecular Genetics/ Cancer Genetics
- Experience with or understanding of clinical laboratory processes
- Good interpersonal and communication skills
- Strong scientific writing skills
- Strong team player in an international business
- Work requires willingness to work a flexible schedule with remote communication and possibility for significant travel

### WORKING CONDITIONS

CSLs will be located in Boston and report to the company's Executive Director, Medical Affairs. Training will be required, located in The Woodlands, TX.

Interested and qualified candidates should apply by sending a cover letter and CV to [careers.us@molecularhealth.com](mailto:careers.us@molecularhealth.com)



## EDITOR'S PICK



## 3D printing: you read it here first

From Richard Ellam

Chuck Hull undoubtedly made stereolithography or 3D printing a practical reality (22 October, p 40). But he was not the first to suggest it. *New Scientist* played a small part.

Older readers recall fondly the wonderful inventions of Daedalus, a weekly contribution to your back page by David Jones, a chemist from Newcastle upon Tyne. Daedalus was the archetypal mad scientist, totally amoral and lacking in all common sense. Most of his ideas have, thank goodness, never seen the light of day, but occasionally he came up with a properly feasible scheme by accident. Thus he found himself proposing more or less exactly the same kind of stereolithography that Chuck Hull developed 10 years later (3 October 1974, p 80).

Paulton, Somerset, UK

From Ralph Hancock

Daedalus imagined a process very similar to, but earlier than, Chuck Hull's first method of 3D printing in 1983. He suggested developing a liquid monomer that would be polymerised when simultaneously illuminated at two frequencies. Directing two laser beams into a vat of the stuff would create a solid object of absolutely any shape – "even complex interlocking and re-entrant shapes quite impossible to mould".

London, UK

To read more letters, visit [newscientist.com/letters](http://newscientist.com/letters)

## Several reasons to feel very tired

From Keith Bremner

Emma Young treats fatigue as if it were only a medical problem (15 October, p 28). In many cases it can be an engineering issue. As a designer of heating, ventilation and air-conditioning systems with over 30 years' experience, I believe that I have stumbled over some of the traps.

Willis Carrier was the first person to design a modern air-conditioning system. His designs called for about 20 per cent of the air passing through the system to come from outside the building. This ventilation component uses about 50 per cent of the system's energy, on average, so there is a temptation to reduce the outside ventilation. Chemicals from carpet, furniture, building materials and even people can then pollute the air and make us feel tired.

In Carrier's designs conditioned air came into contact only with zinc on galvanised steel or with the copper of cooling coils. Zinc and copper have recognised antimicrobial properties. But in the 1970s came new designs using materials such as aluminium, with few or no such properties.

Brisbane, Queensland, Australia

From Adam Brett

I was surprised that your very interesting in-depth article on tiredness made no mention of caffeine. Like virtually everyone I know, I regularly consume tea, coffee or cola to boost alertness on a temporary basis. I wonder whether the tiredness many complain of is not in fact simply a withdrawal symptom?

London, UK

From Chris Rogers

I suggest one more factor that could result in tiredness – noise. My kitchen has a washing machine, tumble drier, fan oven, electric kettle and microwave, and

even the new taps are noisier than the old ones. One or other of the family usually has radio, TV or CD player on. Outside, traffic is heavy and noisy; shops and restaurants often have music playing...

Orpington, Kent, UK

From Stephanie Trotter,  
CO-Gas Safety

Thank you for providing sensible explanations for the feeling of being tired all the time. There is a further simple possibility: carbon monoxide (CO) poisoning stemming from faulty heating or cooking appliances powered by any carbon-based fuel, including gas, coal, oil, petrol or wood.

At very low concentrations, symptoms of CO poisoning include headache, tiredness and confusion. It cannot be detected directly by any human sense. A concentration of less than 2 per cent CO in the air can kill in between 1 and 3 minutes. The independent charity CO-Gas Safety has lobbied government and industry since 1995 for prime-time TV warnings about this.

We have been ignored – or told that such warnings are "so last century".

Seaview, Isle of Wight, UK

## No reason to kill 'problem' wildlife

From Marc Bekoff

Animal rights researcher Bidda Jones identifies three circumstances that supposedly "justify lethal wildlife control" (22 October, p 18). Of course, none really do.

As Alice Klein reports, killing "problem" animals hasn't really worked in the long run when mass slaughter is the method of choice. What I found surprising is that there is no mention of the rapidly growing international field called "compassionate conservation", something Dan Ramp and I wrote about for *New Scientist* (21 June 2014, p 26). A number of the

examples of culling wildlife given are from Australia, where killing often is "the name of the game".

It would be good for those who vote to kill so-called problem animals to first visit the Centre for Compassionate Conservation at the University of Technology, Sydney. Numerous humane non-killing alternatives exist and need to be implemented – because killing doesn't work and raises numerous ethical questions for which there are no easy answers.

Boulder, Colorado, US

## Many reasons for longevity boost

From Kristina Smith and  
Mark Cashley

There are more reasons than Clare Wilson gives for life expectancy in the UK increasing throughout the last century (8 October, p 10). Infection control should not be overlooked. There were 250 deaths from tuberculosis alone per 100,000 people at its peak, now reduced to almost zero.

Lung and stomach cancer decreases in men account for a further 65 per 100,000 – in large part due to changes in tobacco use and environmental controls. The decrease in the cardiovascular death rate for the same period is 150 per 100,000 – also due in part to environmental changes, as well as lifestyle changes and to improvements in emergency care and dental health.

The two most authoritative medical journals in the UK are at odds over how much statin drugs have contributed.

Newport-on-Tay, Fife, Scotland

## Peace in the valley with plenty for all

From Gregory Sams

David Flint questions whether peace and equality could have existed in the Indus Valley for

“People are more tendentious than I can ever recall. It’s terrifying that reasoning has no effect”

Renee Lascala is daunted by the challenge the US faces in healing its political rift after the election (5 November, p 18)

700 years without birth control, or conflict (Letters, 15 October). But today we find that the birth rate goes down, not up, in developed, war-free cultures.

If the Indus culture was not consumerist, there would have been adequate resources for all. That aside, the idea that we need conflict before we can enjoy peace is one of the greatest oxymorons afflicting our culture today. *London, UK*

## Having a whale of a time saving seals

From David Hampton

Robert Pitman suggests that humpback whales are helping seals escape killer whales because of inadvertent altruism (15 October, p 42).

I can see another possible explanation, beside weakening the killer whales or reducing their numbers, so that more humpback calves survive (Letters, 5 November). Could the seals be helpful to the humpbacks in a way that we are not yet aware of,

so that the humpbacks are protecting them for that reason? *West Dean, West Sussex, UK*

From Ian Downie

I can see another benefit for whales protecting seals from orcas. It is play. Young mammals learn by playing; for some species playfulness continues throughout adulthood, making these creatures better able to learn and adapt than those tied into instincts locked in their genes.

“Balance your enemies’ food out of reach” sounds like fun. If I were a humpback whale, I’d want to play that game.

*Southampton, Hampshire, UK*

## Beaver-scented perfumes take guts

From Robert Antonucci

You note that beavers’ anal secretions are used in perfume and other products (22 October, p 36). I’d like to know about the brave men and women who do the harvesting. It’s not easy even to capture a beaver. I once lived on

a property with an artificial lake. There was an overflow cut into the dam, which was key to preventing it washing away – but the beavers didn’t like that strategy, and kept damming it up.

Many nights I’d have to go out during lightning storms and confront them, tearing down as they built. I was braver then.

Harvesting these secretions sounds doubly difficult. *Santa Barbara, California, US*

## How are the odds on climate change?

From Peter Basford

While reading of Jules May and Andrew Collins’s bet on whether global mean temperature would exceed that of 2015 within 10 years (Letters, 22 October) I saw the Italian RAI 24 news station stating that 2016 was well on course to break the 2015 record.

The most exciting aspect of the bet may be how many post-Brexit pounds May will need to pay the \$1000, early next year. *Potters Bar, Hertfordshire, UK*

## Partying, or not, time after time

From Richard Weeks

Jonathon Keats reports Stephen Hawking issuing invitations to a party for time travellers after the event (10 September, p 42). If I hold my own party, can I validly be at all disappointed at non-attendance until I actually issue the invitations?

At that stage I can presumably become disappointed, both in the then present and retrospectively.

What, though, if someone did turn up at the party? I would feel very tempted not to issue the invitation, just for the hell of it. Perhaps, though, nothing would happen (or would have happened, or be about to happen) until the actual moment I didn’t do it. *Felixstowe, Suffolk, UK*

## Who is stealing whose genes?

From Martin Greenwood

How can Sarah and Seth Bordenstein be sure that the WO bacteriophage stole its genes from a spider (15 October, p 8)? Could the black widow spider not have acquired its poison gene from an invading bacteriophage? *Stirling, Western Australia*

The editor writes:

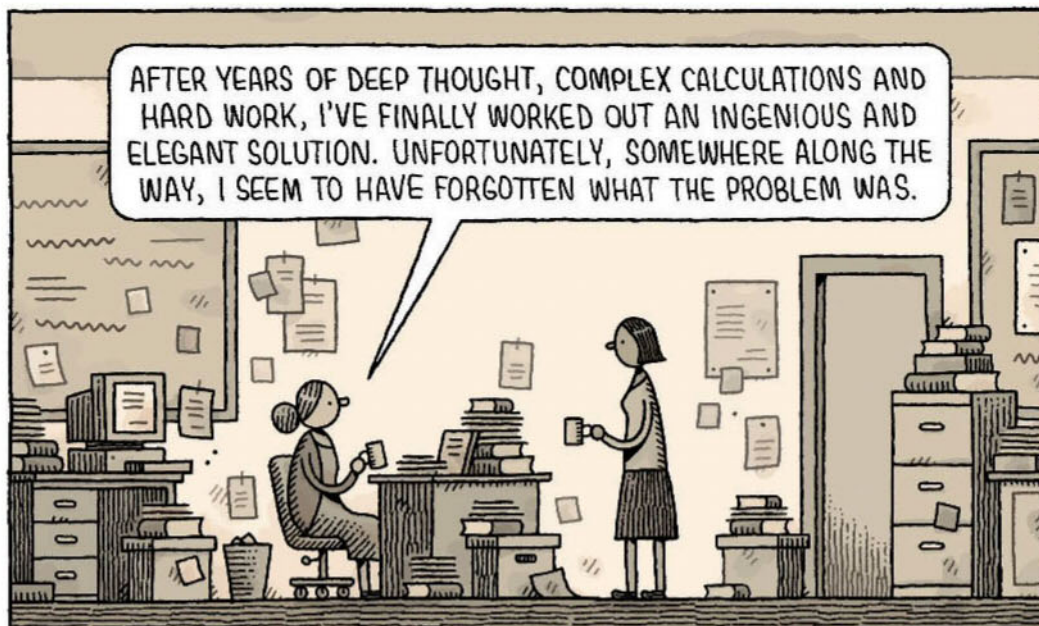
■ The gene is more likely to have originated with the spider. It is much longer and more complex than most viral or bacterial genes, and it has sequences with which other spider genes can interact.

Letters should be sent to:

Letters to the Editor, New Scientist, 110 High Holborn, London WC1V 6EU  
Email: [letters@newscientist.com](mailto:letters@newscientist.com)

Include your full postal address and telephone number, and a reference (issue, page number, title) to articles. We reserve the right to edit letters. Reed Business Information reserves the right to use any submissions sent to the letters column of *New Scientist* magazine, in any other format.

TOM GAULD







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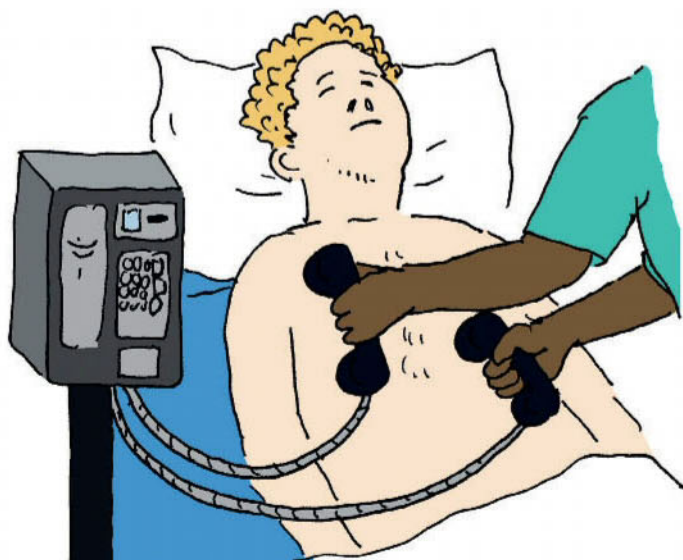
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ANYONE trying to place a call from the public telephone box in Loweswater, Cumbria, UK, is in for a shock. It's one of more than 3000 that have been converted to house a defibrillator by the Community HeartBeat Trust.

Any local community can adopt one of Giles Gilbert Scott's iconic red K6 phone boxes. For £1, you also receive on-brand red and gold paint and free electricity for seven years - though only the 8 watts necessary to power the internal light. The trust will install a defibrillator, which can be unlocked with help from an emergency operator on the other end of the line.

So if you must have a heart attack while strolling in the countryside, try to have it near a phone box.

MORE innovation: we are excited by Daniel Idzkowski's cunning plan to raise a stink about the rate of bicycle theft in San Francisco. His SkunkLock is a secure black-and-white striped lock that, if cut, sprays the thief with a "noxious chemical deterrent".

This will be foul enough to cause fits of vomiting and send

the thief scurrying. Like others, we're not sure how the owner is then supposed to approach the debased bike.

Feedback takes an evolutionary approach to cycle security. We are drawing up plans for a Batesian Mimicry Lock: a cheap, non-stinky version with identical markings, and the promise that you'll return to a pleasant-smelling bike, or no bike at all.

THE robots have arrived, and they brought beer. Crowdsourced taxicab firm Uber announced that a specially designed lorry carrying 40,000 cold ones reached Colorado Springs, US, making the most of the 120-mile trip from the brewery without human hands on the wheel.

While this may be a plot to win over humans by appealing to our baser instincts, some machine learning is required: the truck was loaded with Budweiser, a lager that can be generously described as "inoffensive".

Feedback welcomes our new robot overlords, but we hope they develop a more refined taste in beer.

LOVESTRUCK couples are often characterised as giddy, stupidly happy or having brains that have turned to mush. Now Hiroaki Kawamichi and his colleagues declare, in a paper published in *Frontiers in Psychology*, that there may be some truth in these uncharitable descriptions.

The team studied the brain scans of 113 people, some of whom were romantically involved and others not. The results showed that the loved-up among the group had less dense grey matter in the brain's reward centre.

The researchers' declaration that "being in a romantic relationship is associated with a reduction of gray matter density in the right dorsal striatum" probably won't make for a great Valentine's Day card, but at least it might keep your parents off your back the next time they ask why you've not yet settled down.

THE UK's first national sperm bank has been put on ice after two years, having failed to attract sufficient, er, investment.

The centre was intended to plug a gap in the market that saw infertile couples turning to offshore or unlicensed sources for their gametes, a goal which earned a £77,000 grant from the Department of Health. But staff struggled to get it up and running, managing to attract just seven donors. Funding dried up when the bank could not show financial self-sufficiency.

Feedback notes that the UK government has stepped in before to rescue banks low on liquid assets. Are our elected representatives and peers well-suited to contribute to this one?

GLANCING in the rear view mirror, we recall Penny Jackson being nonplussed by highway signs chiding her that "Picking up your litter risks roadworkers' lives" (29 October).

Drew Rankine writes that in an underpass of the M8 west of Glasgow, a solitary sign proclaims: "CCTV litter enforcement in progress."

Drew wonders whether it is the dropping of litter, or not dropping of litter, that is being enforced.

"Unlike the pedants who write to *Private Eye*, I do get out quite a lot," says Drew, "but I find the modern world more and more confusing."

AS AN earnest student, Feedback could often be found studying in a bar called the Stumble Inn, which many a wag quipped would have been better named the Stumble Out. Eunjeong Park and his colleagues at the Yonsei University College of Medicine in South Korea have developed this notion with a pair of shoes offering, as they put it, "unobtrusive and continuous monitoring of alcohol-impaired gait".

The researchers equipped insoles with pressure sensors that learned the individual walking pattern of 20 test subjects, and could spot when a



sober amble slurred to an intoxicated sway. The future of pub crawls looks promising: once you've filled your boots with beer delivered by robots, a pair of smart shoes will be on hand (or is that on foot?) to march you home.

FINALLY, the UK Land Registry website offers Simon Grant a pop-up: "<< no\_message >>" with the option "Do not show this message again". How will he know if clicking this option works?

You can send stories to Feedback by email at [feedback@newscientist.com](mailto:feedback@newscientist.com). Please include your home address. This week's and past Feedbacks can be seen on our website.

Montgomeryshire MP Glyn Davies confirms our suspicions that politicians live in a different planet to the rest of us, announcing on Twitter: "Personally, never thought of academics as 'experts'. No experience of the real world."

## Pine fresh

Just what is that Christmas tree smell?

■ That Christmas tree smell is the scent of coniferous evolution. Over millions of years, these trees have equipped themselves with a cocktail of chemical weaponry, including substances that act as fungicides and bactericides, and those that deter herbivorous pests, large and small.

The chemical combination varies between tree species, but generally consists of a mix of aromatics, including terpenes such as alpha and beta-pinene, limonene and camphene, and also esters such as bornyl acetate. By happy coincidence, we tend to find these combined scents appealing – so much so that they are added to perfumes and commercial air fresheners.

If you have an artificial tree, you will smell a different kind of ester – probably a phthalate or suchlike – used to make the plastic fronds softer and more flexible.

But if you soak a few tree decorations in pine-scented disinfectant, you can bring a conifer fragrance to your holiday season.

David Muir  
Edinburgh, UK

## A bed of rocks

Railway sleepers often sit on a bed of small stones that act as ballast. This ballast material stretches well beyond the width of the sleepers and to quite

a depth. But why does it have to be stones? Could anything else be used either physically or economically? (Continued)

■ An earlier correspondent discusses ballast without referring to the nature of the rock used, which is a critical parameter. Ideally, the rock should be from a tough and stable lithology.

Samples of the potential material for railway ballast are examined in thin sections by a mineralogist using a petrographic microscope. The aim is to look for evidence of minerals that are likely to break down when exposed to factors such as air, water and load pressure.

In some states in Australia, much of the ancient rock available locally is weathered at the surface,

**"Ideally, rock used for railway ballast should come from a tough and stable lithography"**

and more ideal rock may have to be transported over vast distances. So to save on costs, the ballast used is often less than ideal.

Mining sites are useful because mine waste brought to the surface has not been weathered in the same way. However, this kind of material can cause other problems. In one example, ballast taken from a nickel mine caused degradation of the metal railway sleepers because it contained a lot of pyrrhotite, a very unstable form of iron sulphide. The

pyrrhotite oxidised and produced sulphuric acid, which rapidly corroded the metal.

Concrete beds are not foolproof either. The common "concrete cancer", caused when the cement paste reacts with the rock aggregate, is often a result of coming into contact with unsuitable ballast rock.

Roger Townend  
Townend Mineralogy Laboratory  
Malaga, Western Australia

## Crying foul

Babies in TV or films are frequently depicted crying. How are they made to do this? Does the director wait for the child to cry normally, or is there some scientific method that ensures the youngster doesn't feel pain?

■ I'm a practising midwife and the midwifery adviser for the BBC's *Call The Midwife* TV show, so I have a lot of experience handling babies on film sets. These are not easy places for tiny people, and if they cry it's not usually because that is what the director requires; it is just what happens. Regulations regarding the presence of babies on a film set are understandably restrictive.

The baby is invariably only required for a few minutes at a time, so the child, their parent and their chaperone wait in a room away from the set until they are called for filming.

Although every effort is made to ensure the set is baby-friendly – calm, warm and quiet – this can't

always be achieved. For example, costumes can cause problems because most babies don't like being disturbed to be dressed or undressed. A costume change is made as late as feasible, so the baby is kept with its parent until the last possible moment – helping to keep both the parent and baby content.

The film set is usually an unfamiliar environment for the parent. Although they are reassured and can watch the baby on a monitor, stress levels are still quite high.

The actor will have been briefed and have rehearsed the scene, and where possible will have met the baby before filming, but sometimes this will be the first time they have even held an infant. Babies quickly pick up adult feelings and emotions, so an anxious actor usually ends up holding a crying child. Babies are not made to cry on cue, so any crying that is caught on camera is serendipitous.

Terri Coates  
Salisbury, Wiltshire, UK

## This week's question

### IN-FLIGHT ENTERTAINMENT

The Last Word has recently been discussing how and when Earth's magnetic field flips. I know the odds are huge of such a flip in my lifetime, but what would happen to an aircraft in flight if north and south swapped ends?

Mike Doyle  
London, UK

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